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THE Popular Science Review.

A QUARTERLY MISCELLANY OF ENTERTAINING & INSTRUCTIVE ARTICLES ON SCIENTIFIC SUBJECTS.

EDITED BY JAMES SAMUELSON.

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NOTES OF THE EXHIBITION.

No. V.

THE MACHINERY DEPARTMENT.

BY WILLIAM FAIRBAIRN, LL.D., F.R.S.

NO section of the Great Exhibition afforded so deep an interest to all classes of the British public as the Machinery Department.

Whilst in other divisions it was the object of our neighbours to excel us, all they could hope to do in the province of mechanical engineering was to stand on the same level, and compete with us in a friendly rivalry of skill in constructive art. In many instances they succeeded; but we believe that every connoisseur of the subject who visited the Exhibition, and every reader of the following remarks, will agree with us in thinking that, notwithstanding the rapid and creditable progress made elsewhere, Great Britain still holds the proud position of being at the head of nations in mechanical appliances and engineering proficiency.

A word of apology before we commence our task. Amongst the numerous readers of this Journal, many are well acquainted with the technicalities of natural science,—less, probably, with those of the engineering arts; and if here and there we have been led to employ terms of a technical character, it must be remembered that we are dealing with embodiments of the conceptions of the most advanced minds of the day, and we are compelled to refer to the application of principles which few can fully understand.

As far as possible, however, we have endeavoured to steer clear of abstruse subjects; and if we should occasionally touch upon principles, or their applications, which some of our readers do not fully comprehend, we hope that they will be tempted to inquire further and make themselves masters of their precise character.

In order to enable our readers to form a clear conception of

the advanced stage to which the mechanical operations of the engineer have attained, it will be necessary to examine —

1st. The sources from which we obtain the elements of motive power, comprising the steam-engine, its varieties, forms, and application.

2nd. Water-power, as exhibited in water-wheels, turbines, and other hydraulic machines.

3rd. Grinding, crushing, and cutting machines.

4th. The machinery for the manufacture of textile fabrics.

5th. Locomotive machinery and railway plant.

Lastly. The machinery of agriculture.

In following these divisions of our subject, we have for the source of all power the heat of the sun, which, according to the last new theory of Professor W. Thomson and Mr. Waterton, is produced and maintained by a constant shower of meteoric matter which falls into that luminary. Assuming this to be true, a continuous supply of cosmical heat will produce any description of motive power, which we convert into mechanical force by the combustion of fuel, and by this and other contrivances abate the necessity for muscular exertion in man and animals. To the same source may be traced the vivifying principle of animal and vegetable life; and the deposits of past ages, which we are now using as an agent of accumulated force or work accomplished, and which constitute, in almost every case, the necessary conditions where motive power is required. To the labours and experiments of Black, Carnot, Mayer, Regnault, and Joule we are indebted for the two principal laws of thermo-dynamics, which are, according to the construction of Mr. Mallet, thus stated, namely :—

That heat and mechanical force are reciprocally convertible, and heat on being evolved, requires, or when it disappears, returns in mechanical force, an equivalent of 772 foot-pounds for each English thermal unit, viz., for the heat of one degree of Fahrenheit's thermometer in one pound of water.

In other words, an increment of heat that will raise the temperature of one pound of water one degree is equal to raising 772 lb. one foot in height. This is Joule's equivalent, and has now become general as a measure of work done in foot-pounds.*

Steam and steam-engines are the most important agents now in use as a motive power in Great Britain, and from these alone we receive nearly the whole of the force that is at present

* The resistance of one pound evercome through a distance of one foot is called a foot-pound.

in operation in manufactures, steam navigation, locomotion, and mining. The extent of this force, in this country alone, has been differently estimated. In 1859 it was nearly as follows:—

Steam-Engines employed.	Horses' Power.	
	Nominal.	Indicated.
In Mining and Metal Manufactures	450,000	1,350,000
„ Manufactories	1,350,000	4,050,000
„ Steam Navigation	850,000	2,550,000
„ Locomotion	1,000,000	3,000,000
Total	3,650,000	10,950,000

Or about 11,000,000 horses' power, raising 33,000 lb. one foot high in one minute, or equivalent to the enormous force of raising 162,053,575 tons one foot high in one minute, or 1,620,535 tons to the height of 100 feet in the same time. This was estimated as the work done per minute three years ago; now it has increased to upwards of 12,000,000 horses—which may be taken as the motive force in the British isles alone.

It would be interesting to know the quantity of coal consumed for the purpose of generating a force equivalent to raising the above enormous load of 9,723,214,500 tons one foot high in an hour. This, as already stated, would require the strength of 11,000,000 horses to accomplish in one hour, and this multiplied by five, the average consumption of coal per hour per horse-power, gives 24,533 tons, or about 25,000 tons, as the rate of consumption per hour for the steam-power of Great Britain and Ireland.*

Steam-Engines are of three classes,—Stationary, Marine, and Locomotive; and these are again subdivided into Condensing and Non-condensing Engines. Nearly all at the present time work the steam expansively; that is to say, they are so arranged in the construction of the valve motions, as to cut off the communication with the boiler at one-third, one-half, or two-thirds of the stroke, as the case may be, in regard to pressure, or the power to overcome the resistance of the load. Some engineers go so far as to cut off the steam at one-sixth and one-eighth, and expand the remaining five-sixths or seven-eighths of the stroke.† The expansive system is now thoroughly

* *Vide* "Useful Information for Engineers," p. 206.

† The distance which the piston travels is called the stroke, and is twice the radius of the crank.

understood, and is in almost every case resorted to, with a great saving of fuel. Of late years the principle of expansive working was very imperfectly understood, and the result of its introduction was an immense economy; for more than double the quantity of work is now done with the same quantity of fuel, of what was formerly accomplished on the old non-expansive principle. It must, however, be borne in mind, that this cannot be effected without an increase of the pressure of steam, and hence follows the necessity of having the boilers of increased strength and improved construction. The neglect of these precautions has resulted in serious and fatal accidents, attended with a considerable loss of life and property.

Irrespective of increased pressure, and working the steam expansively, the speed of the engine has been increased about one-third since the days of Watt. In his time the piston of the stationary engine travelled at the rate of 240 feet per minute; now it averages from 300 to 320 feet, and this, combined with high-pressure steam worked expansively, increases the power of the engine, in some cases, upwards of twofold, and, as already stated, doubles the quantity of work done with the same quantity of fuel. Thus an important saving is effected to this and every other country where steam is employed as an agent of power and motive force.

Having ushered in our observations with these necessarily technical remarks, we may state that the Exhibition of this year does not present any new nor original conception in the construction of stationary engines, with the exception of the non-condensing engines, which, in this case, have their cylinders horizontal instead of vertical, as exhibited in the old construction. There are some advantages in this, as the cylinders of the non-condensing engines are comparatively small, and are less liable to wear oval than would be the case in the large condensing engines. These engines are, however, chiefly used as assistants to the stationary condensing engine, and effect a saving by the steam being employed twice over, for it first propels the piston of the high-pressure horizontal engine, after which it is conveyed to the cylinder of the large condensing engine, where it finishes the work at a considerably reduced pressure.

These double engines are mere substitutes for the compound engine of Woolf,* with this disadvantage, that considerable loss is sustained by condensation in the transfer from one engine to the other; and taking into account the back pressure and other causes, this combination is less effective than the united compound engine. But exclusive of

* Woolf is the inventor of the double-cylinder engine.

these drawbacks, it is found from practice that the non-condensing engine does nearly the whole of the work, and in many instances drags forward (if we may use the expression) the piston of the old condensing engine along with it. The work done by the larger engine is, therefore, nil, or little more than what is gained by vacuum and condensation. In the Woolf or compound principle, this is not the case to the same extent; but it yet remains to be solved what benefit there is in a more expensive and more complicated construction, when the same advantages can be obtained by the single cylinder.

That is the question for solution, and to which the advocates of the double cylinder reply, that in working with high-pressure steam, the force applied to the piston of the first cylinder is diffused over a much smaller area, and the action is less severe upon the working parts of the engine than if forced, with the velocity of impact, upon the surface of a greatly enlarged piston, as in the case of the single-cylinder condensing engine. This, to a certain extent, is correct, only it does not effect the economy but simply the strength of the working parts of the engine. Again, it is stated that the double-cylinder engine produces from the same cause a more uniform motion than the single-cylinder engine. But the advocates for the single-cylinder system affirm that these objects are all attained, first, by cutting off the steam at a point that will produce the same rate of expansion as in the compound engine, and this, although suddenly effected, is fully compensated by the action of the fly-wheel, at the greatly increased speed of the engine.

We have been the more particular in this description, as the question is not yet settled amongst practical men which of the two systems is the best; each side has its advocates, with proofs which they adduce in confirmation of their respective theories. Without entering further into this question, we may, however, state that we would prefer the single-cylinder engine, where the advantages are the same as those of a more complicated form; for it appears to us that no benefit is gained in the shape of economy by the double or the compound engine; on the contrary, we are inclined to believe there is a loss in the former, owing to the difficulty of working them together as one engine. The same reasoning will apply to what is called the M'Naught principle, which consists in placing a high-pressure cylinder at half-stroke, under the main working beam of the ordinary condensing engine, and exhausting the steam from one cylinder to the other, on the same principle as already described in the double, horizontal, and vertical system.

Having described the different forms and conditions of our stationary engines, and the improvements that have been

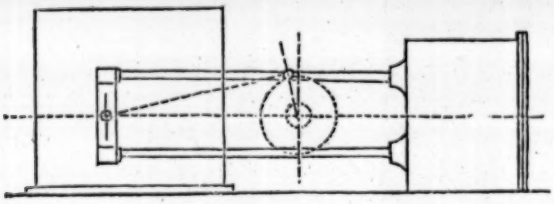
effected by the introduction of high-pressure steam worked expansively, we may conclude this part of the subject by observing, that we are far from arriving at that point of economy in the use of steam which an increased pressure and a still greater expansion is calculated to attain. It is true that the danger of explosion may be increased, and so it would with our present means; but in our locomotive engines we already work steam at 200lb. pressure on the square inch with greater safety than is done in our stationary engines at a reduced pressure; it is, therefore, evident that we are behind in this department, and a wide field is still open for improvement. It is not our province in this article to point out how this can be accomplished, but we may safely affirm that the improvements already attained are only the precursors of others of much greater importance in the economy and use of steam.

Marine Engines.—In this department of constructive art this country stands pre-eminently forward in advance of all others at the Exhibition. It is not the principle nor yet the power that attracts notice, but the application, design, and construction of a machine calculated to propel a vessel of 6,000 tons burden, at a rate of from fourteen to fifteen knots an hour, and yet so small and so compact, compared with the magnitude of its force, as to excite the admiration of every beholder. In this department of mechanical science we have, concentrated within a space little more than twenty feet square, a force equivalent to 2,600 indicated horses' power, and that with all the conveniences of approach to every part of these powerful machines.

For examples of engines of these colossal dimensions and compact form, we have only to refer the reader to those of Penn, Maudsley, Rennie, Humphries, and others, to convince him of the superiority of their construction, the mathematical accuracy with which they are designed, and the precision with which they have been manufactured. In these respects they are superior to anything before accomplished in this country. Several specimens of a different kind have been exhibited from France and other parts of the Continent; but they are not the best examples of the industry of those countries, excepting some small engines from Sweden, and a beautiful double-acting engine for river boats, by Messrs. Escher & Co., of Zurich. As a whole, the marine department has been well represented by engines of great power, and working models (chiefly by Maudsley & Field) of great beauty.

If our limited space permitted, we might have gone more into detail, showing the various contrivances of the working parts; under the circumstances, we must confine ourselves to the following outlines of the different types of marine engines,

as exhibited by the different makers, showing the space they occupy in the ship, length of cranks, &c., as per sketch, taken from Mr. Mallet's report in the *Practical Mechanics' Journal*.



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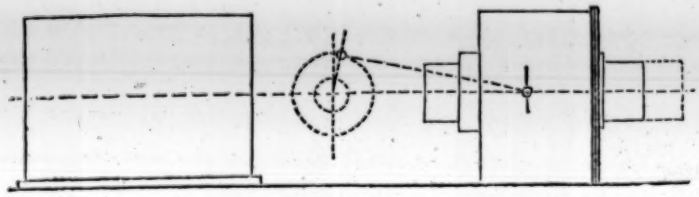

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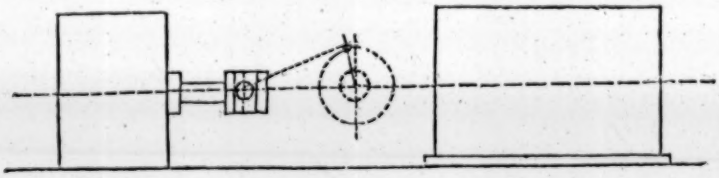

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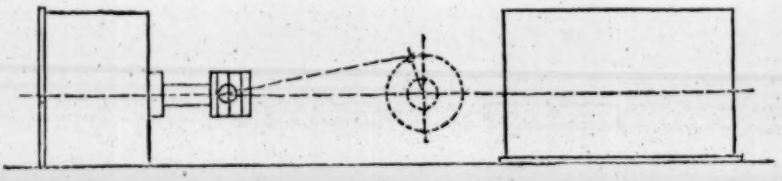

No. 4.

From the above it will be seen that No. 1, with the double piston-rod and reversed connecting-rod, occupies the least space in length; No. 3, with a three-crank connecting-rod, the next; and subsequently follows No. 2, trunk engine, in the order of length; and, lastly, No. 4. Mr. Mallet classes them differently by taking the crank as the unit of measure; from which it follows, that the direct-acting engine, with short connecting-rod, occupies a much less total length than either of the others. This saving of space on board ship is always a desideratum in the construction of marine engines, and is a point carefully attended to in the British navy.

Most of the engines are of the screw-propeller kind, and

the specimens exhibited are certainly of the highest order, whether as regards design or workmanship. The working parts are chiefly composed of wrought iron with a link-motion for working the valves. Paddle-wheel engines are not exhibited, excepting only in models, and a pair of oscillating engines, including drawings and models of Maudsley's annular cylinder engine. Most of these have been in use for years, and are, therefore, deficient in novelty when compared with the more compact form of the screw-propeller class. Altogether the Exhibition in this department is replete with admirable specimens of marine constructions, and we have only to instance the 600 nominal horse-power engines by Penn, and the 800 horse-power by Maudsley & Field for the iron-plated frigate *Valiant*, with others of less power, to be assured of the wonderful development of mechanical science in this age of progress.

To marine constructions we have to add a great variety of vertical, horizontal, and angular engines, adapted to almost every possible purpose where power is required. Some of these engines have double, high, and low pressure cylinders, with and without condensers; others are single cylinders of peculiar construction, and exhibit several new arrangements accompanied with surface-condensation * and other contrivances for superheating steam † and preventing the escape of heat. All these are improvements on the past; but those which have been effected during the last seventy years (although valuable in themselves) are not such as affect the general principle arrived at by Watt, and subsequently perfected by the same comprehensive intellect that made the steam-engine what it now is, the strong arm of power and the hard-working agent of civilized existence.

Water-Power.—Half a century has scarcely elapsed since water was the prime agent as a motive force. To that element, and to wind, we had recourse when power was required for the purposes of mining, agriculture, or manufacture; but the limitation of supply and requisite height of fall required for power were so great, and so uncertain, as to cause frequent stoppages of the works, and to spread them widely distant from each other over the face of the country. At the commencement of the present century, when the improved machinery of Arkwright and Crompton created a demand for power on a large scale,

* Surface-condensation is a vessel where the steam is condensed by pumping cold water on to the exterior surfaces of tubes through which the steam passes.

† Steam is superheated by passing the pipes containing the steam through flues or vessels containing air at a high temperature.

the whole of the river and mountain districts were searched for suitable sites for mills; and for a series of years it was found necessary to take the mill to the power and not the power to the mill, as it has been since the introduction of steam. In some countries it is still desirable to employ water as a moving power, and hence follow the numerous improvements that have taken place in the construction of water-wheels, turbines, and other hydraulic machines. As late as 1830 water-power was still in demand in this country; but from that time to the present it has been considered of little value unless it be in some districts where the power is considerable and where the weirs, aqueducts, and mill dams already exist. For a number of years the mills for cotton, corn, and flax were turned by water, and the construction of water-wheels was greatly improved by making them entirely of iron, which took place at the beginning of the present century. The late Mr. T. C. Hewes was one of the earliest improvers of water-wheels on the suspension principle, and this was followed by a new system of ventilation, by which the buckets were relieved of air on the entrance of the water, and subsequently restored at the lowest point of discharge. By this ingenious but simple contrivance the duty of the water-wheel was raised to a maximum, and the construction of water-wheels composed of iron arrived at a very perfect state. It was at this time that the investigations of Poncelet and the perseverance of Fourneyron introduced the horizontal wheel, founded on principles established by the former and adopted, after careful experiments, in the shape of the turbine by the latter. For several years the turbine made slow progress, as its advantages were not superior to that of the water-wheel, which maintained and still retains its reputation in regard to the amount of work done with a given quantity of water. The turbine, however, occupied less space, was somewhat cheaper in its original cost, and became general on the Continent and America. Of late years the turbine has been greatly improved in this country, and we have several admirable specimens in the Exhibition, a few of which it will be proper to notice.

In every description of machine recipient of water it is a universal condition that the water, to attain its full efficiency, should make its entrance and take its departure at a slow velocity. This has never been done with the turbine, but a close approximation has been attained by the best-constructed water-wheel. Smeaton, in his experiments on water-wheels, attained something above 80 per cent. of the theoretical fall, and some of the best wheels of the present time have arrived close upon that point of efficiency. Now, the best-constructed turbines seldom exceed from 65 to 70 per cent. There are,

however, certain advantages peculiar to the turbine which do not belong to the water-wheel; namely, that it can be made to work waterfalls of from 300 to 400 feet in height; and what is of considerable importance as regards efficiency is, that it works well in back-water.

There are three different descriptions of turbines.

1st. Turbines in which the water passes vertically through the wheel.

Wheels of this class are composed of two annular cylinders, the upper fixed and the lower revolving on a vertical axis. The upper is fitted with guides to direct the water most efficiently against similarly curved vanes or buckets, turned in the opposite direction, in the lower wheel. The water passes from the reservoir or cistern, placed over the upper cylinder, vertically downwards, acting on the revolving wheel by pressure as it glides over the surface of the vanes. Burdin, about 1826, invented a turbine of this description (*turbine à évacuation alternative*), the efficiency of which was about 67 per cent. of the theoretical fall.

2nd. Turbines in which the water flows horizontally and outwards.

In turbines of this class the revolving wheel is placed outside of the fixed wheel, so that the water directed by guide-plates on the inner wheel strikes the curved vanes of the outer wheel, and forces them round by pressure and reaction. The water is regulated by a cylindrical sluice fitting between the fixed and movable wheels.

M. Fourneyron's turbine is the chief example of this class. Its advantages, as stated by M. Poncelet in his report to the Academy of Sciences at Paris, are the high velocity at which it may be worked without reducing its useful effect, its small size, and lastly, its capability of working equally well under back-water. From the experiments of M. Morin, the co-efficient of useful effect * appears to range from 0·60 to 0·80. On the other hand, it has to the full the defects of this class of machines, requiring the utmost nicety of design and execution, and being very susceptible of injury from small bodies carried into it by the water. It requires for its successful application both a large acquaintance with the principles of its construction and a considerable experience of its use.

3rd. Turbines in which the water flows horizontally inwards; vortex wheels.

We owe the invention of this class of turbines to Professor James Thompson, C.E., of Belfast, and probably no turbines

* The coefficient of useful effect is the per-centage of the power expended as compared with the work accomplished.

are more efficient or capable of more general application to every variety of fall than the vortex wheels which he has constructed.

The peculiarity of these vortex wheels consists in the arrangement of the fixed guide-blades on the outside of a circular chamber, in which is placed the revolving wheel, so that the water flowing inwards strikes the curved plates of the revolving wheel tangentially, and leaves the wheel at the centre at a minimum velocity; the whirlpool created in the wheel-chamber giving to this description of turbine its designation of vortex wheel. These wheels are constructed by Messrs. Williamson & Brothers, of Kendal, who, we believe, have at present erected all that are employed in this country.

In addition to the horizontal wheel or turbine, there are centrifugal pumps and water-pressure engines. The first and most important is by Mr. Appold, and to that gentleman the country is indebted for many ingenious mechanical contrivances. Messrs. Gwyne have also contributed to the centrifugal pumping system, and both have splendid specimens of their different constructions at the Exhibition. The principle on which this machine is based, is a small wheel, which is driven at a great velocity,—as many as from 800 to 1,000 revolutions per minute, at the bottom of the suction-pipe. This wheel or fanner with blades is driven by a steam-engine, and, revolving at great speed in a tight box, forms a vacuum in the suction-pipe and forces the water before it, up the discharge-pipes to the required elevation.

These machines are simple and effective where the water has not to be raised to a great height, but they are inapplicable for high lifts, and require a considerable amount of power to overcome the friction and pressure of water in the pipes. It is a question yet to be solved as to whether they are equal, on the score of economy, to the common pump. In fact, they are the same as a scoop wheel surrounded by water in a close box.

Those who have witnessed the imposing effect of these machines at work in the Exhibition, cannot be otherwise than struck with the large body of water which they discharge at a height of 12 to 15 feet, and without entering into comparison as to cost or the force employed to raise a given quantity of water, we nevertheless arrive at the conclusion that this system of raising water is well entitled to consideration.

The water-pressure engine, exhibited only in models and drawings, is employed for the same purpose as the centrifugal pump. Steam-power is not used in this case, but is obtained from the pressure of a column of water, which, acting upon a plunger, generates a reciprocating instead of a rotatory motion.

Engines of this description have been long employed in the mining districts of this country and the Continent. Professor Rankine states, that for the most successful application of these engines, as regards efficiency, it is necessary that the motion of the water should be slow, and as far as possible without shock. Three to six strokes per minute, or a velocity for the piston of one foot per second, is about the ordinary speed. The stroke also should be long, and therefore "the most advantageous use to which a water-pressure engine can be put is the pumping of water, to which slow motion and a long stroke are well adapted, because they are favourable to efficiency, not only in the engine, but in the pump which it works."

Grinding, Crushing, and Cutting Machines.—The Exhibition has been fruitful in this department of machinery, some of them being exceedingly well constructed, and entitled to every commendation for the high finish bestowed upon them. Of late years corn-mills have been greatly improved, and the system of arranging the millstones in a line along one side of the mill, and rendering the whole of the processes self-acting by an improved system of cleaning, brushing, and separating the grain with elevators, Archimedian screw creepers, and an improved process of wire and silk dressing, give a degree of perfection to the manufacture that could not be attained when the grinding machinery was less perfect. Several small mills, chiefly on the French system of driving the stones with belts, are exhibited; and others with high-pressure horizontal engines, driving from two to four pairs of stones, are entitled to notice for convenient arrangement and the superior finish of the workmanship.

Several examples of machinery for the colonies are exhibited from Liverpool and Glasgow, and most of these are of a class calculated to meet all the requirements of complete trains of sugar-machinery; as comprised in the steam-engine, rolls for crushing the sugar-canes, evaporating-pans, and centrifugal machines. In this description of machinery there is no particular novelty or improvement, excepting only the steam-engine, which of late has undergone some change in rendering the whole apparatus more portable and convenient for exportation. In oil and powder mills the examples were not striking at the Exhibition, if we except the grinding and compressing apparatus of Messrs. Samuelson & Co., of Hull. That firm exhibited a complete set of hydraulic pumps and pipes, for extracting the oil from the seed inclosed in canvas bags. They also exhibited a pair of edge-stones in motion, which created considerable interest as a point of attraction to visitors during the exhibition.

The Machinery for the Manufacture of Textile Fabrics comprises the largest class of ingenious machinery and clever contrivances ever submitted to public inspection; and these may be divided into machinery for the manufacture of cotton, for flax, and for wool, including stranding and rope machinery of every description. The length of this article, and our limited space, will prevent us from noticing in detail the numerous machines now in use in the different processes of manufacture, from the raw material to the finished article ready for the market. In cotton alone we have no less than from twelve to fifteen preparatory machines, in as many distinct processes, before the article is converted from the cotton into cloth; and these are distinguished as machines for opening, blowing, carding, drawing, slubbing, roving, spinning, winding, wooping, dressing, and weaving, exclusive of other subordinate processes. In all these operations may be seen an automaton system of movements, regulated with the same precision and nicety as a timepiece. It appears almost fabulous, the amount of work done and of power expended in this department of manufacture alone, and the number of hands employed, not as prime movers, but as "tenters" feeding the machines, *unhappily no longer in daily use, for the production of this colossal manufacture.* Many of our readers may not be acquainted with the magnitude of this important branch of national industry; but we may venture roughly to state, that the annual value of this manufacture is upwards of £70,000,000 per annum, and gives employment to nearly one million of persons, or, with its dependencies, upwards of two millions.

The cotton machinery is well represented in this year's Exhibition, by Messrs. Platt, Hetherington, Dobson, and others; and the adaptation, style, and character of the machinery are of the first order, and do the mechanical genius of this country great credit. All the minutiæ of construction appear to be attended to, and the utmost care observed, so that all the preparatory processes are performed by the machines, with a degree of exactitude far exceeding that of the human hand. Of late years a most ingenious machine has been introduced from Alsace, in France, as a substitute for carding. It is a combing machine, and its operations are so exact, and its work so perfect, as to enable the spinner to produce a finer description of yarn from an inferior quality of cotton. This machine is available for the finer numbers of yarn, and is one of the most important inventions since the days of Arkwright and Crompton. It has undergone great improvements since its introduction into this country, and is now extensively employed in the preparatory processes for flax and wool, as well as cotton.

The power-loom combines within itself many important improvements in twills and figure-weaving. The revolving shuttle-box, and the changes that may be effected in colour and form, cause a close run between it and the Jacquard; and many of the beautiful fabrics in cotton, wool, alpacas, and mixed goods, are woven by these looms, and that with a degree of despatch equivalent to nearly forty yards of cloth per loom per diem. To this department of machinery the contributions have been large and successful, and pattern looms from almost every district distinguished for a particular manufacture have been exhibited.

The same degree of progress is observable in flax machinery as in cotton; and the screw-gill machinery first introduced by the late Sir Peter Fairbairn is strikingly exemplified in the Exhibition. A whole train of this machinery, consisting of heckling, carding, roving, and spinning, is exhibited by different makers; and judging from the superior workmanship and adaptation of the machines to the various processes, we should infer, that in flax the same progressive improvement exists as in that of cotton or any other description of manufacture. The same may be said of the long wool, alpaca, and mohair manufacture; but it is much to be regretted that samples from the great works of Saltaire have not been exhibited. The Exhibition has not been well represented in short-wool machinery; but several specimens from Leeds and the West of England are to be seen, exhibiting improvements on the old system of manufacture. From Belgium there are, however, some very good machines, together with several ingenious contrivances for the preparatory process, and for the ultimate finish given to the cloth. In the manufacture of woollen cloth, the Belgians are not behind, if they are not in advance of the manufacturers of this country.

Locomotive Machinery and Railway Plant.—Of all the changes effected by steam, that of locomotive travelling on a road of iron is the most wonderful, and this country has reason to be proud that it has cradled and nursed this Herculean machine from infancy to maturity. It is not the invention of one individual, but the labour of many; and none have done more for insuring its efficiency than the two Stephensons, father and son; not that the late George Stephenson had any extraordinary inventive powers, but he possessed a keen sense of observation, and an indomitable perseverance in every pursuit in which he was engaged; and hence followed his great success as a railway engineer. It is curious to trace the early beginnings and history of this machine from the time of Trevethick and Blenkinsop (as given by Mr. Smiles in his interesting work, "The Lives of the Engineers"), to its final completion in its

present high state of perfection. As a steam-engine, there is nothing new or striking in its form or construction; its power and success depend almost entirely on the boiler as a generator and a never-failing source of supply of steam. To this small vessel, 11 feet long and 3 feet 10 inches in diameter, with a square fire-box at the end, we are indebted for the almost incredible performances which we daily witness on every line in the kingdom. Few of our readers are probably acquainted with the simple yet effective contrivances by which this comparatively small vessel exercises such enormous power over a dead weight of two hundred tons, which it hurls along on its iron course with a velocity far exceeding that of the swiftest race-horse. This is the work of a machine mounted on six wheels, and contains within itself, at a pressure of 150 lb. per square inch, a force of 7,000 tons bottled up ready for use. A tithe of that force could not be generated in the same space but for two causes; namely, the large heating surface exposed to the action of the furnace, and the blast from the cylinders into the chimney. It is to the first, as the recipient of heat, and to the second, creating a draught through the furnace, that this enormous force is due. To the philosopher and engineer these principles are familiar; but to those who have not examined the parts, and made themselves acquainted with the principles on which they are based, they must ever remain an enigma.

It will not be necessary in this place to point out and describe the uses of the different organisms of this very tractable and powerful machine; suffice it to observe, that in so far as regards simplicity of design, quality of material, and sound construction, the English engineer is in advance of all his competitors; yet certainly not so far ahead but that he may be overtaken and distanced in the race, unless he maintains his position as a leader and trainer in the mechanical sciences and constructive art. It must be acknowledged, in justice to our foreign neighbours in France and Germany, that their engines are not only well made, but they combine several ingenious contrivances for the ascent of steep gradients, and the safe working of tortuous lines in mountainous districts. The only fault that can be urged against the foreign engine is the complexity of its parts, and a want of that simplicity of form which distinguishes the English construction.

In the locomotive department there is nothing new to record, excepting that the engines and tenders, as a whole, are superior in power and construction to those which were exhibited in Hyde Park in 1851, and at Paris in 1855. We must not, however, lose sight of Giffard's injector, for supplying the boiler with water; and a novel invention by Mr. Ramsbottom, the engineer and locomotive superintendent of the London and

North-Western Railway, for supplying the tender with water when the engine is running. This ingenious apparatus consists of a dip-pipe or scoop attached to the bottom of the tender, with its lower end curved forwards, and dipping into the water contained in an open trough, lying longitudinally between the rails at about the rail level, so as to scoop up the water and deliver it into the tender-tank while running. The speed in practice at which water is picked up varies from a minimum of twenty-two miles per hour.

By means of this apparatus, the size and dead weight of tenders for running a given distance are reduced, as also the time required on the journey. It has been in use on the Holyhead line since October, 1860, and since that time, about 2,250,000 gallons have been picked up. Another trough has lately been laid down on the Liverpool and Manchester line, and a third near Wolverton—the last being intended for the use of the fast trains which run between London and Rugby, a distance of eighty-two miles, without stopping. The picking-up apparatus was illustrated in the Exhibition by a working model. An engine, similar to that exhibited, has run from Holyhead to Stafford, a distance of 131 miles, without stopping, in 144 minutes: being at the average rate of 54½ miles an hour. An engine of the same class lately brought the mail train from Holyhead to London, a distance of 264 miles, being the greatest continuous run ever made by one engine. The average speed was 42 miles an hour.*

The Machinery of Agriculture imports a new era in the history of mechanical science, and in this uncertain and precarious climate it is a desideratum that we should have the means, not only of preparing the soil, but we should avail ourselves of every favourable opportunity for gathering in the crops, and housing them with safety in wet weather. In tracing the history of our agricultural improvements, it will be found that they originated with a few distinguished men in the south-eastern parts of Scotland, and with the father of English farming, Arthur Young, the great breeder, and the most talented of English farmers. To these men we owe the first movement in agricultural improvements, and from their time up to the present there has been steady progress. It would not be too much to say that the produce of the soil of this country has been trebled within the last century, and the quantity of land reclaimed from sterility, and the improvement of that previously cultivated has been such as to excite the wonder of the past, and to stimulate the exertions of the present generation. Even as late as the beginning of the present century, although much had been

* *Vide* "Practical Mechanics' Journal," p. 272.

done in draining, accompanied with the new system of rotation of crops, comparatively little had been accomplished in the shape of machinery as applied to the labours of the farm. The south of Scotland took the lead in a superior class of implements for tillage, and the thrashing-machine, driven by water and horses, was introduced about the same time by Andrew Mickle, of East Lothian; but steam as a substitute for animal power had never been thought of, and until the last ten or fifteen years the great steam arm of science remained a listless agent, inoperative in the hands of the agriculturist.

At the present day, the very reverse is the case: as steam-engines, steam-ploughs, and other steam drudges of the farm, are not only appreciated, but they testify their value by their presence at the Exhibition.

In this display we recognize one of the most imposing sights in the world's fair, and it is not too much to say that the agricultural mechanician has equally distinguished himself for solidity of construction, simplicity of details, and economy in price, with his contemporaries, the marine and locomotive engineers. The steam-ploughs of Fowler, and the engines and machinery of Ransome & Clayton, may challenge competition in any department of mechanical science, and the implements generally in this important division are exceedingly well made and admirably designed for the purposes for which they are intended.

Reaping-machines of almost every description are well represented at the Exhibition, and there appears to be no end of cultivators, grubbers, and sub-soilers, all of which are carefully designed and well made. In the construction of reaping-machines, considerable improvements have been from time to time effected by Smith, Bell, McCormack, and Crosskill; but the labours of the engineer are of little value, unless supported by the agriculturist in the preparation of the land, so as to render it available for the work of the machine. To make a reaping-machine work well, *everything* must not be left to it; the farmer has his duty to perform in preparing the land as well, as the machine, and that being carefully accomplished, the great problem of machine labour will soon be solved, and the farmer may then calculate with certainty upon securing his crops in the worst of seasons. In a variable climate, such as that of England, where a whole harvest may be lost or seriously damaged unless rapidly cut and securely housed, the machine reaper becomes invaluable, and cannot fail, when properly constructed and applied, to become the farmer's friend, and a great national benefit.

Miscellaneous Articles and Machines.—Our limited space will not permit us to enter into detail, or we should have noticed a considerable number of machines and objects well

entitled to consideration: we may, however, remark that amongst them is a splendid collection of tools of varied forms of construction; such as lathes and machines for boring, planing, grooving, and slotting, including steam-hammers, riveting, punching, and wood-cutting machines of every description. All these are well and ably represented by the first makers, and for these as well as for the paper and letter-printing-machine makers, too much cannot be said; the ingenuity and skill with which these valuable and important machines have been produced surpass all description.

If we examine the state of society as it now exists, in comparison with what it was nearly a century ago, and observe the amount of work then done by manual labour without the assistance of machinery and the steam-engine, it will be found that the labour of one individual in those days was not more than one hundredth part of what it is at present; and this immense increase of work does not arise from any increase in the muscular strength of man, but from his having called to his aid that all-powerful and never-failing agent steam, and the beautiful organisms to which its power is applied.

We might instance innumerable examples by which the ingenuity of man has, by appliances and the adaptation of machinery, turned to account the natural products of the earth to supply his wants, and contribute to the social comforts of his existence. In the manufacture of cotton, one man will spin one thousand times more yarn than could have been done before the introduction of the steam-engine and machinery; and in the manufacture of iron, the work of one individual with the aid of the rolling-mill, is increased nearly in the same proportion. Other manufacturing processes have undergone the same beneficial changes, and we have reason to hope, from the exertions of an intelligent and well-conducted population, that the advantages thus gained will be preserved and increased throughout future generations.

Having thus glanced, however imperfectly, at some of the leading objects in the machinery department of the great International Exhibition recently closed, we may safely state in conclusion, that more splendid and more instructive examples of the useful arts were never at any previous time brought under the inspection of the public. There is no department of practical science which has remained unrepresented, and the student, mechanic, or engineer, had only to read in his own department of study the great page of nature and art which, at this Exhibition, was laid open for his perusal. It is a great privilege for the present generation to have had before their eyes the finest specimens of the manufacturing machines in operation in their day, and in the construction of which it

is their ambition to excel. This is an advantage of which few countries can boast, and it is of a character that will leave its impress upon the public mind, and will raise the thinking and industrial portion of the community of this and of all other nations much higher in the scale of civilization.

No. VI.

THE IMPLEMENTS OF WAR.

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IN comparing the Exhibition of 1862 with that of 1851, it must have struck all observers that in nothing was there greater change—advance—improvement if you will—than in the implements of war. In no other department could there be a question whether or not such improvement was a subject of congratulation. Is it so here? An interesting inquiry no doubt, but wholly beside the object of our article. We can but note the fact. The causes are obvious. In 1851, Europe had, for five-and-thirty years, enjoyed, comparatively speaking, a profound peace. Since then, two European wars, a protracted struggle in America, and a general feeling of uneasiness that a third war may break out in Europe at any moment, have directed universal attention to the subject.

The effect of this attention has been very marked; whereas in 1851, with the exception of a few military men and sportsmen, no one took the slightest interest in improvements in rifles and such instruments, for the last few years there is scarcely a schemer with an idea, and a belief in his own ingenuity, who has not come forward with his inventions; scarcely a firm of mechanical engineers which has not dabbled in patents for guns, armour-plates, forts, and so on. People who had perhaps never heard of a rifle, and certainly did not know the precise difference between that and a smooth bore, are now well up in the latest performances of "Whitworths" and "Armstrongs" (which the daily papers publish in their most prominent columns), and are ready to give a decided opinion on their respective merits. This is enough to account for the great stride which has been made during the last ten years. To note all the instances of improvement, and to describe them, would require a much greater space than that at our disposal. A con-

sideration of the principles involved in these changes, which is all that we can attempt, may, however, be of interest.

The substitution of the rifled bore, with the elongated projectile, for the smooth or plane cylindrical bore with the spherical bullet, may be regarded as the main element. And yet the invention of the rifle and elongated shot was not new even in 1851. To take one instance, Captain Norton had for some twenty or thirty years, and others for a longer or shorter period, been advocating elongated and expanding projectiles, which are now universally adopted for the small-arms of every European army, without receiving the least encouragement. This is one of the many examples of inventions, which, coming before the world was ready for, or required them, have fallen still-born. Indeed, the mathematician Benjamin Robins, who may almost be considered the father of modern gunnery, as far back as 1747, published a short work explaining the true use of the spiral grooves of the rifle and their great value in insuring accuracy, and suggested how advantage might be taken of them to enable us to employ elongated (egg-shaped) projectiles which would give increased range and accuracy. He concludes with the following remarkable prediction:—

> I shall, therefore, close this paper with predicting that whatever state shall thoroughly comprehend the nature and advantage of rifled-barrel pieces, and, having facilitated and completed their construction, shall introduce into their armies their general use with a dexterity in the management of them, they will, by this means, acquire a superiority, which will almost equal anything that has been done at any time by the particular excellence of any one kind of arms, and will perhaps fall but little short of the wonderful effects which histories relate to have been formerly produced by the first inventors of fire-arms.

His advice was neglected for a hundred years. Might we not with safety refer to the Austrians at Solferino, and the Chinamen of the Taku forts, for confirmation of the truth of his prophecy? It appears as if the strong impulse which is necessary to force on a change had never till lately been called into action; though, at the same time, in the case of large guns — heavy ordnance — another cause must be allowed to have exercised a certain amount of weight. Without the means afforded by the steam-hammer and other modern mechanical and manipulative contrivances, it would be impossible to construct such guns as those of Sir W. Armstrong or Mr. Whitworth, or their ammunition. This, however, does not apply to the more simple constructions followed on the Continent, and which might have been as effectively employed fifty years ago.

We will now attempt, though necessarily in a very superficial manner, to elucidate the reasons for a rifle being a

more accurate and far-reaching weapon than the old smooth bore; for without some knowledge of these, the changes can scarcely be appreciated. Neglecting the form of the outside at present, let us consider the interior only, and following the Irishman's receipt for making a gun, as the first stage, "take a long hollow," and we have the long cylindrical bore, closed at one end, in which the charge of powder is ignited, and which, becoming very rapidly, though not instantaneously, converted into gas, drives the projectile—a spherical bullet—before it in one direction, and the gun in the other.* Unless the gun be a breech-loader, the bullet must necessarily, for ease in loading, be rather smaller than the bore. Through this interstice, termed *windage*, a great deal of the gas escapes uselessly; whence there is a great loss of initial velocity. And further, the bullet goes bounding along the bore, striking first against one side and then the other, and leaves it, not in the direction of the axis of the piece, but in some other direction, depending on the side it struck last, which is one cause of inaccuracy; but it also, either from having rubbed against one side of the bore more than the other, or from its not being perfectly homogeneous,—when the centres of figure and gravity do not coincide, — carries with it a spinning or whirling motion, which is another and more important cause of inaccuracy. For this rotation causes great deflection, in the following manner:— Owing to its rapid motion, the air becomes more condensed in front of the bullet than behind; in fact, when the velocity is more than 1,344 feet per second (the rate at which air will rush into a vacuum), there is a complete vacuum behind it. If we imagine the bullet to combine with its motion of translation, a rotation from left to right as we look down upon it while facing in the direction in which it is going; that is, representing the bullet in plan by a shilling, in the direction that the superscription runs; then the air being denser before than behind, there will constantly be a greater friction on the anterior than on the posterior half of the bullet, —a friction that is opposing the motion of rotation of the front half to the right, and therefore tending to deflect or make the

* The *permanent* gases generated occupy, it is computed, at the temperature supposed to be produced—3,000° Fahr.,—a volume of about 2,000 times the bulk of the powder. But this point, as well as whether, at this high temperature, Marriott's law of the elasticity varying as the density holds good, has never been accurately determined. If, however, we take Dr. Hutton's estimate, which is rather a low one, that the first force of fired gunpowder is equal to 2,000 atmospheres (30,000 lb.) on the square inch, and that, as Robins computed, the velocity of expansion is about 7,000 feet per second, we have some idea of the force.

shot roll off to the left. But at the same time one half—supposing the bullet to be cut in two, in the opposite direction, by the plane of the trajectory—is moving in the same direction with, and the other half against, the motion of translation. That is, in the case just considered, the left half would be rotating in the same direction as the motion of translation, the right half in the opposite direction; consequently, the motion of the right half would be assisting, and the motion of the left retarding, the air in escaping past it. The bullet, therefore, constantly creating and meeting a denser medium on the left than on the right, has a tendency to deflect to the right. This tendency, which is in the opposite direction, is stronger than the one before mentioned, and the ball is deflected to the right—in a curve, as the velocity of rotation diminishes less rapidly than the velocity of translation.* In the same way the range is increased or diminished according as the rotation of the fore part is upwards or downwards.

From these remarks may be gathered the general causes which give uncertainty to the direction of the flight of a spherical ball from the smooth-bored gun; viz., uncertain rotation and the resistance of the air. In the rifle we have a means of counteracting these by imparting a constant and fixed rotation. The rifled barrel, instead of being a plain cylinder, has spiral grooves cut in it. The ball fits these grooves, and in being forced out by the powder, is constrained, in the same way as a screw in being withdrawn from a nut, to rotate round an axis which is the same as that of the bore of the gun. This rotation is constant, and the tendency is for the axis of a rotating body to remain parallel to its original direction,† as may be easily seen with a spinning-top; and, moreover, the axis being coincident—at all events, during the early part of the flight—with the line of the trajectory, the causes of deflection before considered do not come into play, while, at the same time, any irregularities of surface are brought first to one side and then to the other; and any deflections which might be caused by them are neutralized.

Having now shown how the inaccuracy is overcome, let us examine how the range is increased. The obstacle to an in-

* Robins showed this very well by an experiment with a bent musket-barrel; the ball, instead of following the direction to which the end of the barrel was bent, was incurvated in the opposite direction, and crossed the direction of the straight portion. The ball, in fact, rubbing against the bent portion, received a strong rotation in the opposite direction, and, as explained, was deflected.

† See Mechanical Summary, p. 277,—"Guns and Iron-cased Ships,"—a new form of projectile.

crease of range is the resistance of the air, which, with high velocities, is very great, as may be gathered from the following experimental resistances to a ball two inches in diameter, extracted from a table given by Dr. Hutton. With a velocity of 100 feet per second, it was ·174 lb.; with 200 feet, ·709 lb.; with 900 feet, 94·106 lb.; and with 2,000 feet, 102·362 lb. As the resistance is nearly proportional to the surface exposed to it, so, to gain increased ranges, it is necessary to increase the weight of the ball in a greater ratio than the surface exposed. For if two balls, one twice the weight of the other, exposing the same surface to the resistance of the air, are projected with the same velocities, the heavier having twice the momentum or store of motion, has twice the power of overcoming the resistance; that is, twice the range. With smooth-bored guns and spherical shot, the only way of accomplishing this (increased density being practically out of the question), is to increase the diameter of the shot, when the weight increasing as the cube, and the surface as the square of the diameter, the desired result is obtained, as far as the other circumstances will admit.

With high velocities (as was shown by Dr. Hutton), the resistance rapidly rises in a variable ratio, which increases more and more above the square of the velocity; so that, beyond a certain point, the increase is of no avail.

In the rifle, however, the power of impressing a rotation gives us an advantage in overcoming the resistance of the air. For, as the tendency is for the axis of a rotating body to remain parallel to its original direction, if we project an elongated shot, it will be maintained with its point foremost during the flight, and, in proportion to its weight, will present a very small surface to the resistance of the air. Thus, if we compare Mr. Whitworth's 3-pounder with the old 3-pounder, the weights of the shot are the same, but the diameter of the spherical shot is 2·91 inches, and of the Whitworth 1·5 inch; the surfaces are, therefore, as 8·47 to 2·25; that is, the Whitworth, with an exposed surface of only about one-fourth that of the 3-pounder, has the same weight wherewith to overcome the resistance offered by the atmosphere. Hence the enormous range that was obtained,—9,688 yards, or upwards of 5½ miles. It must not, however, be inferred from this that the projectile may be indefinitely increased in length, and increased ranges thereby obtained. For as the powder is by no means instantaneously converted into gas, we very soon arrive at a limit beyond which it is useless to increase the charge; for it would not be wholly exploded before the shot left the gun, and we arrive at a point where the velocity is decreased without any corresponding gain. It is perhaps right to notice here the

erroneous idea, that an elongated rifle projectile has a much greater initial velocity than a round shot. A little consideration will show that this is not the case. With the same pressures acting through the same spaces, that is, similar charges fired under like conditions, the velocities of the shot will be inversely as the square roots of their weights. Besides which, in the case of the rifle, there is the work lost in friction and in giving the rotation. Where the rifle does gain, is in this; that whereas, *cæteris paribus*, the initial velocities are inversely as the squares of the weights, the resistances of the air rise in a much higher proportion than the squares of the velocities, when these are high. A limit is, therefore, reached beyond which it is useless to increase the velocity of the round shot, and which it is possible nearly to attain with the rifle projectile. The following table, extracted from the "Lectures on Artillery," by Major Owen, R.A., and Captain Dames, R.A., at the Royal Military Academy (from which work we also, by their kind permission, copy the drawings of the gun and fuzes), will illustrate these remarks, showing, as it does, that at first the higher velocity of the 12-pounder round shot gives it the advantage over the Armstrong.

	RANGES AT ELEVATIONS OF—					
	Point Blank.	1°	2°	3°	4°	5°
12-pounder Armstrong, weight 6 cwt., charge 1 lb. 6 oz.....	300	600	900	1,200	1,500	1,600
12-pounder (service), weight 18 cwt., charge 4 lb.....	300	700	1,000	1,200	1,400	1,600

This table, moreover, does not fully *express* the difference in initial velocities of the two shot; for, paradoxical as it may appear, the ranges of the elongated projectile are, up to about 6° of elevation, absolutely greater in the resisting atmosphere than they would be *in vacuo*; for the elongated shot, from its rotation, retains the same inclination to the horizontal plane throughout the flight, and consequently acquires a continually increasing obliquity to the curve of its flight. And the effect of this obliquity is, that the projectile is in a measure sustained upon the air, just as a kite is supported by the current of air meeting the inclined surface; and its descent being retarded, it has time to reach a greater distance. At least this is Sir W. Armstrong's explanation, and there is no doubt that whereas the 12-pounder with an initial velocity of about 1,600 feet per

second, does not, at 2° of elevation, attain two-thirds of the range it would have *in vacuo*, the Armstrong, with an initial velocity of about 1,050 feet per second, exceeds it by about 120 yards.

From the above-mentioned obliquity of the elongated projectile to the curve of its flight, and the consequent unequal action of the resistance of the air above and below, arises a deviation in its flight, which is termed *derivation;* but this is constant for similar ranges, and can be allowed for.

We now come to a practical difficulty in the manufacture of large guns. This difficulty was found even in making round-shot guns of above eight inches in diameter of bore, strong enough to withstand the charge required to impart high velocities to solid shot; and with elongated shot this difficulty is greatly increased, because the weight of the projectile is increased in proportion to the size of the bore. For as was pointed out, we believe, first by Dr. Hutton, it is of no use to increase the thickness of metal in the gun beyond a certain point. Let us take the cross-section of a gun, that is to say, an annulus, and inquire, what is the precise action of the exploded powder on this? We know that iron in resisting a tensile strain is extended (a small portion of the extension, from want of perfect elasticity, being permanent), and the gun, or the portion of it which we are considering,—the annulus, is therefore enlarged, this enlargement being, to a great extent, only momentary. But though it is enlarged, the area of the annulus, which, being the cross section, represents the amount of metal in the gun at that point, must remain the same; therefore the width must diminish; or, which is the same thing, the circumference of the inner circle must be increased in a greater ratio than the outer; *i. e.*, the inside of the gun must be more stretched than the outside. Now, if we consider the annulus divided into its component concentric rings, the greater the distance of each successive ring from the centre, the less will it be stretched, the less will be the strain on it, and the less good will it do,—till we arrive at a point when the inside of the bore or inside ring will be ruptured, before any strain is taken by the outside; so that, beyond a ceertain point, increasing the thickness of the metal is useless.

In order to make the gun sufficiently strong, various means have been suggested (Captain Blakeley, some of whose guns were in the Exhibition, having been, we believe, one of the first and most successful in practically meeting the difficulty), such as shrinking or driving on rings of metal on an inner core, or by winding wire on it with an increasing strain, so that what is called an "initial tension" is given to the outside of the gun; and the successive rings of the annulus

in their normal state vary from a state of *compression within* to *tension without;* each part thereby bearing its own work—that is, when the strain comes on it, the whole thickness of the gun is serviceable in resisting it.

We have now to consider the projectile. Windage, or the looseness of the bullet in the bore, for ease in loading, has been before adverted to, with the inaccuracies to which it gives rise. In the rifle, where the spherical bullet was used, there was necessarily no windage, for the bullet, in order to take the grooves, was (except in the two-grooved rifle with belted ball) forced down by a heavy ramrod and mallet. This difficulty in loading was, indeed, one of the main objections to the rifle. Breech-loaders and expanding bullets afford means of avoiding windage and yet loading easily.

The methods by which the modern cylindro-conical projectile is made to take the rifling, or fit the grooves of the gun, may be classed under three heads:—

1. The mechanical fit, where the projectile is made of the exact form of the bore before being inserted in it. The projectile may be of hard metal throughout. This plan has been adopted by Mr. Whitworth, Mr. Lancaster, Captain Blakeley, and others, in England, and in all the foreign ordnance we have seen.

2. By making the projectile (which must, therefore, be at least coated with a soft metal) rather larger than the bore of the gun. It is inserted at the breech, which is enlarged to receive it, and it takes the rifling by being forced forward by the powder and crushed into the grooves. This plan is adopted by Sir William Armstrong,* and also in many breech-loading small-arms.

3. By the projectile, which is of some soft metal, as lead, and is small enough to be loaded at the muzzle, being made to expand into and take the grooves by the explosion of the powder. The projectile, then, generally has a hollow at the base, in which a wooden or iron plug is inserted. This having less specific gravity than the lead, is driven forward by the discharge, and expands the bullet. It is found also, that when the projectile is proportionately rather long, the hollowed base, either with or without a plug, is unnecessary; the expansion takes place sufficiently without it, from the explosion acting in the manner of a blow, and forcing the base of the cylinder forward before the front has had motion communicated to it. This plan, though very generally adopted for small-arms, has never succeeded with ordnance. In small-arms it is very generally

* Sir W. Armstrong has, however, made some of his large guns muzzle-loaders, on the *shunt* principle, which is of the nature of a mechanical fit.

Whitworth Shot

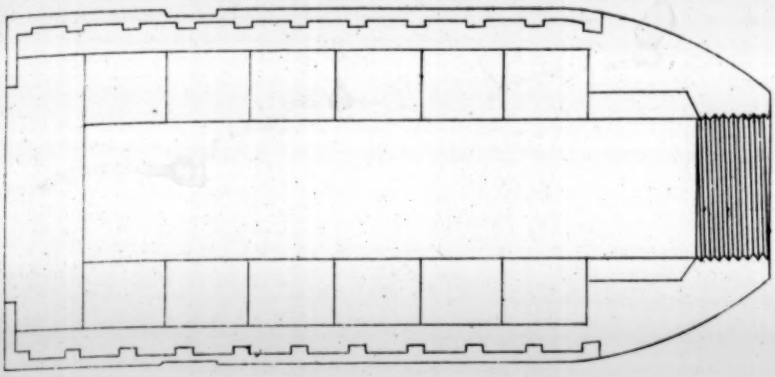
Fig. 5

Whitworth Flat headed Shot

Fig. 6

Fig. 2

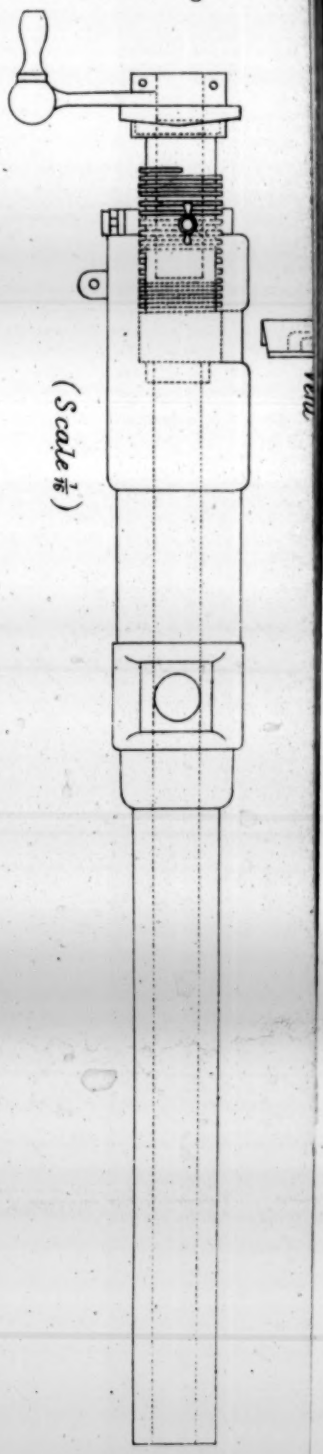
Armstrong Shell



Half Size

Fig. 1

Armstrong Gun.

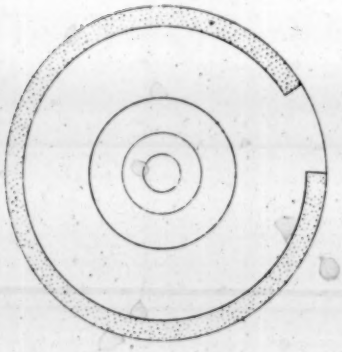


(Scale $\frac{1}{48}$)

Fig. 3

Armstrong

Time Fuze



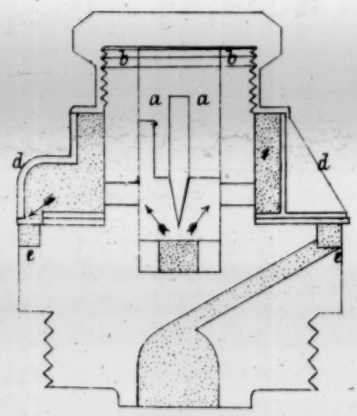
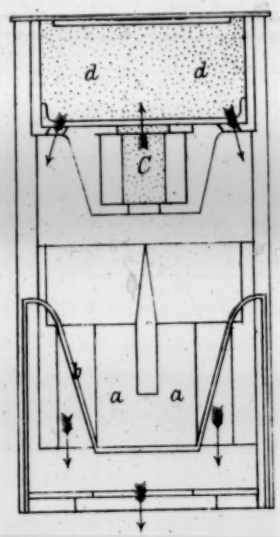


Fig. 4

Armstrong

Concussion Fuze



Full Size

aa	*Represents the Striker*	*aa*	*Striker*
bb	*Suspending Pin*	*bb*	*Suspending Pin*
c	*Detonating Comp.n*	*c*	*Detonating Composition*
dd	*Hollow Collar*	*dd*	*Priming Chamber*
ee	*Fuze Composition*		

N. West, Lith.

termed the Minié rifle, Captain Minié, of the French army, having, though he was not the inventor, first brought it very prominently forward. Captain Norton was, we believe, the real inventor of the expanding bullet.

Considering the Armstrong and Whitworth rifles as the most elaborate English types of the two systems of rifling, we will, as far as possible, describe them. In Plate VII. will be seen a drawing of the Armstrong gun, of the shell, and the two fuzes, and drawings of the ordinary and flat-headed Whitworth shot. The process of manufacture of the Armstrong gun is so very complicated that it would be impossible without numerous plates to give a description of any value. Suffice it to say, that the guns are made of wrought-iron bars, coiled and then welded together in lengths of about two or three feet. These tubes are then welded together and formed into a long barrel. This constitutes a core, which is strengthened at the breech, where the action of the powder is the greatest, by similarly made cylinders or tubes of wrought iron, which being constructed of such a size that they are too *small* when *cold*, are put on when *expanded by heating*. When these cool and contract, they afford the necessary initial tension. The breech is forged solid, and welded on. The gun is loaded at the breech through the powerful hollow screw, which is shown in the plate. The charge having been inserted, the vent-piece is dropped into the slot behind it, and tightened up by means of the screw through which the charge was inserted. The vent-piece has a disc of copper on its face, which, by this operation, enters the bore, and by its expansion at the time of explosion prevents any escape of gas. Through the vent in it, the gun is fired. The number of grooves varies in different calibres; in some of the larger ones there being as many as forty. These grooves are very shallow, with one side (the one on which the shot bears while coming out) rectangular, and the other rounded off. The rapidity of twist or pitch of rifling varies from one turn in thirty to one turn in thirty-eight diameters. The bore of the gun, up to a sufficient distance in front of the vent-piece, is smooth and enlarged to form a chamber, into which the shot and charge is pushed by hand.

The following description was given by Sir W. Armstrong, of the projectile—the shell,—in a paper printed by the *Institution of Civil Engineers;* and with some further description is extracted from Major Owen and Captain Dames's lectures:—

The projectile consists of a very thin cast-iron shell, the interior of which is composed of forty-two segment-shaped pieces of cast-iron, built up in layers around a cylindrical cavity in the centre, which contains the bursting charge and the concussion arrangement. The exterior of the shell is thinly

coated with lead, which is applied by placing the shell in a mould and pouring melted lead round it.* The lead is allowed to percolate among the segments, so as to fill up the interstices, the central cavity being kept open by the insertion of a steel core. In this state the projectile is so compact that it might be fired through six feet of hard timber without injury, while its resistance to a bursting force from within is so small that less than one ounce of powder is sufficient to break it in pieces.

The segmental pieces act like the voussoirs† of a bridge in fact, in strengthening the shell; but are easily liberated, when they are very destructive. This same projectile can be used as a shell; by leaving out the bursting charge, as a shot; by arranging the fuze so as to burst it as it leaves the muzzle of the gun, as common case; or, lastly, by arranging the fuze to burst it just before reaching the object, as shrapnel. Such simplicity of ammunition, which further enables one gun to fulfil all purposes of gun and howitzer, is of the very greatest advantage. Two descriptions of fuzes are used by Sir W. Armstrong; the one a percussion fuze for use when it is intended to burst the shell on striking an object; the other, a time fuze, to explode it at any given length or time of range, without its striking an object, as when used as case or shrapnel. It must be remembered that the gun is a breech-loader, and that there is no windage by which the gas or flame of the powder can, as with ordinary guns, get round the shot and ignite the fuze. The latter has, therefore, to ignite itself at the instant of discharge. This is effected by a percussion arrangement; the rest of the fuze being very much on Breithaupt's principle. Sir W. Armstrong thus describes his fuze:—

The body of the time fuze (fig. 3) is made of a mixture of lead and tin cast to the required form in a mould. The fuze composition is stamped into a channel forming nearly an entire circle round the body of the fuze, and is afterwards papered and varnished on the external surfaces. As the shell fitted accurately into the gun, there was no passage of flame by which the fuze could be ignited. The effect is, therefore, produced in the following manner:—A small quantity of detonating composition is deposited at the bottom of the cylindrical cavity in the centre of the fuze, and above this was placed a small weight or striker, terminating in a sharp point presented downwards. This striker is secured in its place by a pin, which, when the gun is fired, is broken by means of the *vis inertiæ* of the striker. The detonator is then instantly pierced by the point, and is thus fired. The flame

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* Mr. Bashley Britten's plan of joining the lead to the iron by an interior skin of zinc is, we believe, now adopted.

† The voussoir is the technical name given to the wedge-shaped stones which constitute an arch.

thus produced passes into an annular space formed within the revolving cover, which rests on the upper surface of the fuze composition; and from this annular space it is directed outwards through an opening, so as to impinge on and to ignite the fuze composition at any required part of the circle. The fuze thus ignited burns in both directions, but only takes effect at one extremity, where it communicates with a small magazine of powder in the centre. The fuze is surrounded by a scale-paper, graduated to accord with the elevation of the gun, so that when the range of a distant object is found by trial, it is only necessary to turn the igniting aperture of the cover to the point on the fuze scale corresponding with the degrees and minutes of elevation on the tangent scale.

The concussion fuze (fig. 4) is on nearly the same principle. A striker with a point presented upwards is secured in a tube by a wire fastening, which is broken on the firing of the gun; the striker being thus liberated, recedes through a small space, and rests at the bottom of the tube; but, as soon as the shell meets with any check in its motion, the striker runs forward and pierces the detonator in front; by which means the bursting charge is ignited.

The Whitworth gun may be either a breech-loader or a muzzle-loader,—that is to say, some are made to load at the breech; but their construction is such, that if anything in the breech-loading apparatus should go wrong, the gun is not disabled, as with the Armstrong, but can be loaded at the muzzle. The form of the bore can perhaps best be understood by examining the shot of which drawings are given (figs. 5 and 6), and imagining the bore which will fit them. It is in fact in section a hexagon with the angles rounded off. If we imagine this section to move along the bore with a rotation which would make one complete turn while moving along a length of twenty diameters (which is the pitch given in the Illustrated Catalogue of the Exhibition, from which the drawings are taken, for all calibres), it gives the bore. Mr. Whitworth constructs all his guns of homogeneous iron, the smaller calibres being simply bored out of a solid bar, and the larger ones strengthened by wrought-iron hoops forced on by hydraulic pressure. To secure ease in loading, without windage (except to a very small extent), those portions of the sides and angles of the hexagon of the bore on which the shot bears while being rammed down from the muzzle, are eased off slightly. The shot bearing close on the other portions when being driven out by the powder, prevents nearly all waste by windage. The ordinary shot, which is cast, is put into a lathe to be faced to fit the bore, though, on occasion, it may be finished in casting. Mr. Whitworth has found that, by diminishing off the tail of the projectile, as shown, a greatly increased range is obtained. The shot with which the extraordinary penetrations, lately reported in the newspapers, was obtained against iron plates, is of the form shown in fig. 6,

flat-headed. Mr. Whitworth's theory is, that the flat-headed shot punches out a portion of metal *clean*, while a great deal of the momentum of the pointed shot is lost in compressing the metal *sideways*, like a wedge, as it penetrates; thereby at each instant creating a greater opposition to its advance. These shot are made of steel or homogeneous iron, or faced with it.

At the late experiments at Shoeburyness, the Whitworth 120-pounder, at a range of 800 yards, sent a flat-headed shell, which, with its bursting charge of 5 lb., weighed 150 lb., through a target consisting of 5-inch iron plates, on a 12-inch teak backing, with a $\frac{5}{8}$-inch wrought-iron skin within, the shell bursting inside. The 70-pounder, at a range of 600 yards, sent a shell weighing, with its bursting charge of 3 lb. 12 oz. of powder, 81 lb., through $4\frac{1}{2}$-inch plates, with 18-inch teak backing and a $\frac{5}{8}$-inch skin. No fuze is required for these shells, as the passage through the iron plates heats them sufficiently to ignite the powder. In the ordinary Whitworth shell the percussion arrangement is not required in the fuze, as the flame can communicate with it. In the Whitworth breech-loader, the breech is closed by a cap which screws on outside. This cap works in an iron hoop, which is attached by a hinge to the side of the breech. When unscrewed, the cap is by this means opened back like a door, disclosing the bore for the insertion of the shot and cartridge. The vent is in the centre of the cap, in the axis of the gun. The cartridge is contained in a tin or copper case, which prevents any escape of gas. The mouth of the cartridge is closed by a lubricating wad, which lubricates and cleans the bore after each discharge. This wad has also now been adopted with the Armstrong gun, and avoids the necessity of constant sponging out.

These few remarks would scarcely be complete without some comparison between the rival systems. General Morin, in the June number of the *Annales du Conservatoire Impérial des Arts et Métiers*, makes some remarks which appear to be just, though there are some portions of the article in which the able author seems to have been labouring under a misconception. He says that the advantages of the Armstrong projectile are compensated for by numerous defects. The manufacture of the projectiles is very delicate. Their nature is such as to require a care in preservation which the hazards of war render it impossible to afford them. While, on the other hand, after describing the Whitworth system, and commenting on what he considers an excess of nicety and exactness in their manufacture, as shown, which is not by any means indispensable, but may on service be found not only superfluous but inconvenient, —he speaks highly of the Whitworth principle, and says that, when the niceties are modified so far as experience and the

exigencies of service may require, the system is worthy of the highest attention.

War is a rough and rude master, and though we cannot but admire the extraordinary ingenuity and the great mechanical skill brought by Sir W. Armstrong to bear in the construction of his guns, and the perfect contrivance which it is, when we consider the great care required even in preventing corrosion or injury to the bore, we may well doubt, without presumption, whether, though tested in a short campaign in China, from starting on a wrong basis, his ingenuity has not been misdirected, in creating a weapon too delicate for the rough handling and neglect inseparably incident to a protracted European campaign.

Our limits forbid our entering on the description of the numerous other ingenious and original inventions exhibited in the military court; such as Captain Fowkes's admirable collapsing canvas pontoons; Captain Boxer's diaphragm shells and parachute lights; and the various small-arms, &c., which rendered this display so instructive. These will be found described in the jury reports, which we have endeavoured to supplement, to a certain extent, by a popular description of the principles involved.

What will all this lead to? Are armies and navies, like the famed Kilkenny cats, to fight till nothing but their tails are left? Where will it all end? These are complex questions, which must have suggested themselves to many. And yet there is a simple solution which presents itself. In affairs of honour with the small-sword, A's and B's seconds would egregiously fail in their duty if they permitted B to use a rapier an inch longer than A's. All A's swordsmanship would be thrown away, his most scientific attack lost, if, when finally lunging on his antagonist, B had simply straightened his arm. Before A's rapier could reach him, that one extra inch had given B the victory; he had "pinked" A.

If an extra length of sword thus secures the victory, one would infer that, in the days when swords were worn and used, they would all have been of the utmost length consistent with the capability of the wearer to wield them. Yet an examination of an old armoury will prove this to have been anything but the case. In the single combat, the chances undoubtedly are, within certain limits, with the longer sword. And yet use and experience seem to have proved that, for all general purposes, a rather under-sized sword was in the long-run most efficient. Is it not so with armies? For an army with the comparatively short-ranged smooth bore to meet another equipped with the long-range rifle, would in all probability be to court defeat,—a probability varying from certainty on a plain, to even chances on very broken ground. A commander cannot neglect any

sudden improvements of his enemy. But when both armies come to improving their arms, and, as a necessary consequence, complicating highly their organization for supply and equipment, will they not, as with the sword, tacitly revert, after experience, to something simpler? The change being, perhaps, hastened, as all history demonstrates, when wars become highly complex, by some man with genius grasping the just medium to which complexity can be carried with efficiency, and, disregarding the long sword of his antagonist, closing with him victoriously. Wars, at all events, have not become more bloody since fire-arms and their improvements have come into vogue.

No. VII.

THE ZOOLOGY OF THE INTERNATIONAL EXHIBITION.

BY CUTHBERT COLLINGWOOD, M.B., F.L.S., &c.

SCATTERED up and down the vast building which has been the centre of attraction to so many thousands during the past summer, the lover of Natural History found ample material to attract his attention, and to encourage him, if he were fortunate to have at his command sufficient time to make a systematic examination of the contents, to devote a day to its zoological and botanical treasures. He would soon perceive, that although there were numberless nooks of the Exhibition which yielded something of interest in this department, nevertheless they were chiefly concentrated about the colonial courts, which in some instances were furnished with scarcely anything else but the animal and vegetable productions of the colony, accompanied by specimens of the raw material derivable from them. This fact at once affords an indication of the manner in which a brief sketch of this department of the Exhibition should be treated; and as the animals and vegetables were thus to a great extent geographically arranged, so also they should be described.

Let us first visit our most distant colonies, which, situated at the antipodes of this country, yield, as might be expected, some of the most remarkable forms of animal life. Victoria, which only emerged into an individual existence in 1851, and is now a flourishing colony of forty-seven municipalities, sent specimens of some of its curious marsupial animals. These creatures, represented by the Kangaroo and Wombat, are characterized

by a pouch or bag, in which the young are carried for a considerable period after birth. This is rendered necessary by the fact that they are born in an imperfectly-formed condition, so that they are incapable of at once existing, like other mammalia, in the outer world into which they are rudely and, as it were, prematurely thrust. They are, therefore, immediately transferred into the maternal pouch, in which the teats are situated, and, fastening on to them, they remain snug and secure from danger. The new-born kangaroo is but an inch in length, blind, and with very rudimentary limbs and tail; and it is believed that this remarkable character has reference to the physical constitution of the country, where water is very scarce; so that, instead of leaving their young, as other animals would do, while they travel great distances to quench their thirst, they are thus enabled to carry with them their helpless offspring, in those long migrations which are necessitated by the scarcity of water. These singular animals are abundant in Australia and Tasmania, which thus form, as Forbes remarked, a peculiar zoological province, where we have the lowest conditions of the vertebrate type assembled, as if to indicate a rudimentary stage of the world's history.

One genus of pouched animals, the Opossum (*Didelphys*), is found in America, and another (*Cuscus*), is Malayan; but with these exceptions, they inhabit no part of the world but those just indicated.

In the Australian courts also might have been seen those remarkable animals the Duck-billed Platypus (*Ornithorhynchus*), and the Porcupine Ant-eater (*Echidna*), anomalous quadrupeds, closely allied, and constituting together the order of Monotremes. The former is aquatic, with a flattened beak, like a duck, and close-set fur, like a mole; the latter terrestrial and insectivorous, with a cylindrical tongue like the true ant-eater, and covered with spines like a hedgehog—both strictly limited to Australia and Tasmania. A very beautiful skeleton of the Echidna, prepared by Professor Hyrtl of Vienna, in the Austrian court, showed the curious marsupial bones, remarkably large in this species. These bones are two in number, diverging forward from the front of the pelvis, for the support of the marsupial pouch. It is not a little noticeable that they are also found in the males, which have no pouch. In some respects these two quadrupeds may be considered to connect the mammalia with the class of birds.

The productions of New South Wales, South Australia, Western Australia, Victoria, and Queensland, may for all purposes be considered together, having very much in common; and with them may be included Tasmania. In all are found the characteristic marsupial animals, of which the

Kangaroo is the best example; the Great Kangaroo, however, is becoming scarce, though the Red Kangaroo, now only found in the interior of New South Wales, is much rarer. The most common Tasmanian species is Bennett's Kangaroo, of which the meat is said by Mr. Gould to be excellent, and which it is believed might easily be acclimatized in our southern counties. The Tasmanian Devil (*Dasyurus*) could not fail to attract notice from its repulsive bear-like form, which is matched by its destructive habits; though the first settlers in Hobart-town repaid their devastations among the poultry by eating them. The flesh is said to taste like veal. The largest carnivorous marsupial, however, is the Tasmanian Wolf (*Thylacinus*), of which living specimens will be found in the Zoological Gardens,—a dog-like animal, striped on the back, fierce and agile, and the terror of the herbivorous Kangaroos and Opossums, though it is said it will not touch the Wombat (*Phascolomys*). A very beautiful case of male, female, and young of these animals, mounted by Ward, was in the Tasmanian court, and is now deposited in the Liverpool Museum. In the pleistocene deposits, however, has been found the skull of a great carnivorous marsupial, termed *Thylacoleo* by Owen, equalling the lion in size and strength; and in the New South Wales court was exhibited the skull, measuring three feet in length, of a vast marsupial, allied closely to the Kangaroo, and called by Owen, *Diprotodon*, another relic of the pleistocene deposits of this singular island.

Some interesting birds were observable in this department. Like the quadrupeds of these regions, the birds are also very strange and peculiar; as, for example, the Apteryx, which inhabits Australia and the islands of New Zealand, and of which three species are now known. These wingless birds, belonging to the Struthious division (which includes such birds as the Ostrich and Cassowary), are almost the only representatives of a class which not long since were tolerably plentiful. As many as twenty species, from the size of a turkey to twice that of the ostrich, have left incontestable evidence of their existence in quite recent times, though now only three, or perhaps four, remain. The wings are reduced to the merest rudiments; the feathers have no accessory plume, and their shafts are prolonged beyond the back. They differ, too, from other birds in having a complete diaphragm, and no abdominal air-cells. These birds are nocturnal in their habits, of weak powers of resistance, and therefore easily fall victims to predatory animals; while their skins are also eagerly sought for by the native chiefs, who ornament their dress with the feathers. They live on worms, insects, snails, &c. In the Exhibition of 1851, it will be remembered that another wingless bird,

though of a different class,—the Dodo, but recently extinct, formed an attractive and prominent feature.

The most gigantic species, however, of these wingless birds was well represented by a beautiful model of a skeleton, in the Austrian court, among the illustrations of the late Government exploring expedition undertaken in the *Novara* frigate. This bird, the *Palapteryx ingens* of the palæontologist, was found in a cave in the Awatere valley, in the province of Nelson, south isle of New Zealand. The original skeleton is at Vienna. But that which gives these birds their greatest interest is the possibility, or even probability, that one species—it may not be the largest—is still existent, though rare, in the middle island of New Zealand, where it is called by the natives the *Moa*. Fragments of the eggs of some of these great birds have also been discovered in New Zealand, bearing a great resemblance to those of the Apteryx, having a thin shell and smooth surface. The Emeu (*Dromœus Novæ Hollandiæ*) is the Australian representative of the ostrich tribe, of large size. This fleet bird, which affords excellent sport to the hunter, is also gradually disappearing before civilization, though at present rather widely diffused over South Australia and the neighbouring islands. Its eggs, which might be seen in the Western Australian department, are dark green, and six or seven in number. Some tippets and muffs also were exhibited, formed of the feathers or skin of a newly distinguished species, first recognized by Mr. Bartlett.

In the South Australian court also was exhibited the *Talegalla* (with a representation of its nest), another of those characteristic birds with which these regions abound. Mr. Gould, who visited Australia with the ardent enthusiasm of a true ornithologist, has given us the best account of this bird, and places it among the *Rasores* (or domestic fowl tribe), and considers it as the Australian representative of the Turkey, which it equals in size.

The Talegallas are gregarious and shy, rapidly running through the tangled brushwood. They utter a loud clucking noise as they stalk about the wood; and, like the ruffed grouse of America, when perched on the branch of a tree, they will sit composedly to be shot at repeatedly till they are all brought down. The most wonderful part, however, of the history of this bird is its nest. It collects together a great heap of decaying vegetables as the place of deposit of its eggs; thus making a *hotbed*, arising from the decomposition of the collected matter, by the heat of which the young are hatched. Mr. Gould describes this heap as the result of several weeks' collection by the birds previously to their laying, and as varying in quantity from two or four cartloads, and of a perfectly

pyramidal form. It appears to be the united work of many pairs of birds, and the same site is used by them for several successive years. The Talegalla uses its foot for this work, and when sufficient is accumulated, the eggs are deposited about a foot apart from each other, and buried about two feet deep, perfectly upright, with the large end upwards; and there they are left, as in an artificial incubator, till they are hatched, when, it appears, that the chicks force their way out without assistance. The natives collect as many as a bushel of eggs from a single mound, and they are much sought after on account of their delicious flavour and large size ($3\frac{3}{4}$ in. × $2\frac{1}{2}$ in.). These remarkable statements of Mr. Gould have all been verified by the behaviour of some of these birds kept in confinement at the Zoological Gardens, Regent's Park, where this strange method of incubation has been observed in every particular.

That *rara avis*, now so no longer, the Black Swan, was conspicuous in the West Australian court, it having been adopted as the emblem of that colony. It is characteristic of Australia, that it should have produced a bird which was once regarded as the symbol of impossibility, and put in the same category with the phœnix and the mermaid. But the pure white of the swan's down was so proverbial that our ancestors, who knew nothing of the extraordinary anomalies of undiscovered Australia, might well be excused from imagining a black swan, except as a joke, such as that which was alluded to under the terms *birds' milk* or *asses' wool*. Shaw first gave the Black Swan the name of *Anas Plutonia*, devoting the new wonder to the patronage of the infernal king. But really a black swan, except in colour, differs but little from our own wild swans, and the form of that characteristic part, the trachea, is intermediate between that of our wild Hooper and the tame swan.

The group of six Lyre-birds, in the Queensland court, doubtless attracted attention. They were first discovered in Captain Flinders' expedition in 1798, and since then have been bandied about among ornithologists, who were unable to agree as to their true position; they have now, however, finally settled into their place among gallinaceous birds. Their discoverer gave them a high character as song-birds, which, however, they have not succeeded in keeping. There is only one species of these splendid birds, whose superb lyre-shaped tails may well have astonished the Irishmen who formed the exploring party when they were originally found. Mr. Bennett says that these tail-feathers are sold in pairs in the shops in Sydney, though they are now becoming rare, and fetch from twenty to thirty shillings a pair. The Lyre-birds inhabit the

forests of Eucalypti (gum-trees) and Casuarinas, and are, like many other Australian animals, becoming scarce.

The Bower-birds (*Ptilonorhynchus holosericeus*) also keep up the character of Australia for its anomalous productions. These birds, with a plumage resembling black satin, are allied to the Crow, and are most singularly interesting on account of the bowers from which they take their name, and which they construct as follows :—With great skill and dexterity they weave a sort of arbour of twigs, fixing them below in a bed of various materials, and decorating their promenade, which is of various length, with shells, feathers, and other ornamental materials, which they collect from the country round. This bower has no connection with their nest, which is built later, but serves apparently as a playground, in which they sport, and play at hide-and-seek, bo-peep, and a variety of similar amusements, which we should hardly expect to have found their way into bird-life. Their bower constantly occupies their attention. They arrange and rearrange the materials every day, placing about it everything within their reach which may by any means serve as an ornament to it. The habits of these birds have also been observed in the Zoological Gardens.

There are many other curious birds known to Australian settlers by peculiar names; such as the "Laughing Jackass," a large kingfisher, whose note resembles a rude powerful laugh, heard more especially at certain hours of the day; and hence it is sometimes called the *Settler's Clock*. Here, again, we have kingfishers which do not fish, indeed seldom come near the water, but feed upon mice, lizards, &c. Australian birds do not excel in their powers of song; and even we English do not usually impute much sweetness of voice to our crows and rooks; but there are few birds with a richer whistle than the Australian piping crow (*Barita tibicen*). Both these latter birds were exhibited in the Victoria court. Parrots and cockatoos, also, the flocks of which annoy the settler by their depredations in his plantation, and by their harsh discordant screams, are characteristic birds. Some of these cockatoos also are black, as the New South Wales court testified; though they do not breed in open mossy nests, as there pretended.

The Victorian exhibition included a number of fishes well preserved in spirits, showing the great resources of this colony. Among these the Murray River cod, or cod-perch (*Oligorus Macquariensis*) was conspicuous, and is said to attain a weight of ninety pounds. It is abundant, and the market is regularly supplied with great numbers of a large size. The Snapper of the colonist (*Pagrus unicolor*), is equally important, though of inferior flavour. The great Maigre (*Sciæna aquila*), is much larger than either of these, and, it is said, a finer fish for the

table. It reaches a length of five feet. The mullet, whiting, and herring, so called by the colonists, are all common fishes, but not identical with our European fishes of those names. The short sun-fish of Europe is often taken in Hobson's Bay, and valued for the oil it produces. A species of tunny and an eel are also commonly used as food.

Until recently no true lobsters nor crabs were known in Australia fit for the table; but a spiny crayfish, equal in size to our river species, is supplied to the markets; and the gigantic Murray River crayfish (*Astacoides serratus*), is also now largely used. An enormous crab, exhibited in the Victorian court (*Pseudocarcinus gigas*), was lately found near Portland, and preserved for this occasion.

But we must pass on to the examination of other courts. The Eastern hemisphere sent but little of a zoological character; the chief feature being found in the Indian and Cinghalese departments. The royal Bengal tigers, prepared by Mr. Ward, of Vere Street, were very striking objects, being represented in the midst of the jungle, the one slinking back, so as to realize the first glimpse obtained of the creature by the party hunting it, as the line of elephants approached its lair; the second tiger was also represented in the jungle, wounded, and charging with fury upon the attacking party. Both were very creditable specimens of the taxidermist's art.

The gorgeous state of Eastern potentates is assisted and enhanced at the expense of some of the most beautiful of the feathered tribes; and peacock's feathers, and marabout's feathers were shown in every condition, to the exclusion of any illustration of the vast and imperfectly-known ornithology of India. The tail of the Yak (*Poephagus grunniens*), which is rich and silky, reaching nearly to the ground, was shown, mounted in a splendid handle, and is used for various luxurious purposes. Indian silk was illustrated in an instructive manner; the silk-producing moths being exhibited in their various stages of metamorphosis, with their food, and specimens of the silk of each kind accompanying.

Ceylon showed her ivory, skins of tigers and cheetahs from the northern province; monkey and goat-skins from the other provinces. Here also might be seen the little musk-deer, measuring seventeen inches long and weighing only about five and a half pounds. Pearls and pearl-producing shells characterized the exhibition from the eastern province.

South Africa contributed hippopotamus' teeth, rhinoceros' horns, skins of those singular armour-plated animals, the Pangolins (*Manis*), closely allied to the Ant-eaters, and termed Edentate, from the absence of incisive teeth. They are scantily distributed and find no representatives in Europe. Antelopes

here abound, but true deer there are none, the only African species known inhabiting the northern parts. But South Africa is the head-quarters of the antelopes, as Asia is of the deer; the former have persistent horns, but the latter shed them periodically.

Turn we now to the Western World. The courts appropriated to our colonies in America and the West India islands contained many objects of the greatest interest. The tropical regions of British Guiana were represented by several strange mammalian forms, birds of strange shapes, and some characteristic vegetable productions. Among the former may be reckoned the Great Ant-eater (*Myrmecophaga jubata*), one of the Edentate group before mentioned. In this animal we have an extraordinary prolongation of the muzzle, the bones of the face being double the length of the skull, and the organs of mastication being absent; but they possess a long cylindrical tongue covered with a glutinous saliva, by means of which they secure insects, and draw them into their little mouth. This tongue is of extraordinary length, nearly twice as long as the whole head and muzzle put together, and when not protruded it is kept doubled up in the mouth with the end pointing backward; with its powerful crooked claws it opens the great South American ant-hills, and although sluggish in its ordinary movements, it uses its tongue with such rapidity, that it is asserted that he will project it and withdraw it covered with insects twice in a second. The use of its immense bushy tail was apparent when we once had an opportunity of seeing this animal compose himself to rest. Lying down on one side, he planted his long snout amidst the thick fur of the belly, and then locking the fore and hind claws into each other, he reflected his tail, so as to cover his whole body as with a blanket. Thus in his native savannahs he probably shelters himself from the too powerful rays of the tropical sun.

Near this animal might be seen another, singularly differing from it in form, though closely allied to it in structure, also Edentate, the Sloth. Here we find the bones of the face short and round, giving the animal a physiognomy akin to that of the monkeys, and the organs of mastication deficient only in incisor teeth. But they possess none of the advantages which monkeys have in the mobility and flexibility of the fingers, nor any thumb; and though they are, like them, arboreal in habit, they hold by means of hooked claws, by which they usually hang with the back downwards. Few animals have been more maligned than the poor sloth, the account of whose habits, by Buffon, gives a vivid but incorrect statement of its pitiable lot. But, as Mr. Waterton observes, "he travels at a

good round pace, and were you to see him, as I have done, passing from tree to tree, you would never think of calling him a sloth."

But Buffon, trusting too implicitly to rumour, gave the ant-eater the credit of climbing trees, which it never does.

A very splendid case of animals in the New South Wales court may be appropriately referred to in this place, inasmuch as their native country is South America, from whence they have been transported to Australia, with the hope of acclimatizing them, and making their habits and their economy alike useful in that distant continent. These are the Alpacas and Llamas, the species of Auchenia. This case contained seven animals of the brown, grey, and black varieties, and well illustrated the important advances which the colonial breeders were making in the production of *lustrous long wool*, by means of judicious selection in breeding; in which particular the exhibitors express themselves as sanguine that in a few years they will not only compete with, but surpass Peru, from whence the animals originally came. The pure alpaca has a finer, heavier, and longer staple of wool, than the pure llama, but a dash of llama blood infused into the alpaca produces a larger framed, hardier constitutioned, heavier, finer, and more glossily-fleeced animal than could ever be obtained by the close in-and-in breeding so zealously carried out by the Indians of Peru. One remarkable use of these animals in Australia, is the following:—Previous to the arrival of the alpacas the native dogs caused great havoc, both by day and night, to a flock of sheep; since their arrival, however, they have not been troubled by these pests; and every day may be seen a few sheep accompanying one of the flock to graze, returning with it at sunset to fold. In South America it is customary to have eight or ten wether alpacas with a flock of one thousand ewe sheep; these alpacas conduct the flock to pasture, defend it from the foxes, condors, and strange dogs during the day, and bring it back to fold by sunset. They attack the dogs in concert, and with boldness, using their fore feet as offensive weapons, and with good effect. The supporters of the alpacas in Sydney unhesitatingly declare that the perfect acclimatization of these animals in that colony is no longer a matter of doubt.

The Jaguar (*Felis onca*) of the British Guiana collections, together with the Ocelot (*F. pardalis*), and the Puma (*F. concolor*), represent the great cats in America, where the lion, tiger, and leopard are unknown. The jaguar is an expert climber of trees, and although not very dangerous to man, commits great havoc among small animals and the flocks and herds of the Indians. They are very numerous, and according

to Humboldt, 4,000 are killed annually in the Spanish colonies, and 2,000 are yearly exported from Buenos Ayres alone.

The peculiarities of geographical distribution were well exhibited by the monkeys of this region, several of which were shown in the Guiana court. The monkeys of this continent differ in so many important points from those of the Old World that they may be considered as a distinct type. Here we have a different dental formula, all Old-World monkeys having thirty-two teeth, while those of America have thirty-six. The latter never possess callosities nor cheek-pouches; the thumb, which is so constant in the case of monkeys of the Old World, is often absent from the fore-feet of American monkeys, which are also of a generally smaller size, and possess a different physiognomy, arising from the very different form of the septum of the nose. But one of the most striking peculiarities is that the tail of American monkeys, instead of being sometimes absent, as in the apes and magots of Africa, is always present in some form, and usually is prehensile, forming an additional hand, which is used with wonderful facility and judgment, as may be seen by any one who will visit the Entellus monkeys now in the Zoological Gardens. Among the South American monkeys, the Red Howler was most noticeable in the Exhibition, an animal with a singularly stentorian voice, calculated to make night hideous in the gloomy and pathless forests of South America.

Nor are the birds of these regions less striking. The case of Humming-birds well illustrated a class of fairy denizens of the New World, such as are not vouchsafed to any countries of the Old—radiant-winged gems—the souls of the warriors who had died in defence of the gods—as the Mexicans fabled.

"Exquisite ornaments are these to an Indian garden," says one who has seen them in their native state, "where they delight in the flowering plants and shrubs. They creep to and fro about the stalks and twigs, clinging by their little purple feet, and rifling the tubular corollas of their honied blossoms, where, doubtless, they gather many minute insects, licked up with the nectar, by the aid of their curiously-pencilled tongue."

The Boat-bill (*Cancroma*), a bird of the heron tribe, attracts attention by his singular beak, like a boat turned upside down. It is a handsome bird, with a long crest hanging backward over the neck, inhabiting Guiana and Brazil. Perched on a tree over a stream, it drops down like a kingfisher upon the passing fish, and seldom misses its finny prey. Its name would indicate that it feeds on crabs, but this seems at least doubtful. Bitterns, horned screamers, Pompadour chatterers, and a variety of other birds, show the ornithological riches of these regions; but few birds are more beautiful than the toucans, whose

brilliant plumage and painted beaks make a splendid appearance. The light spongy substance of their delicately-tinted mandibles prevents them from being impediments to motion, as it might be supposed they were; and the same may be observed of the closely allied birds called Hornbills (*Buceros*), with which, however, they must not be confounded, for the latter are confined to the Old World, while the former are only found in the New.

The Canadian exhibition contained many northern birds, as the snowy owl, great-horned owl, whip-poor-will (a species of goat-sucker);—the American purple martin, passenger pigeon, and yellow-billed cuckoo—birds which have been met with in this country; the northern humming-bird (*Trochilus colibris*), the cedar-bird, the Canadian goose, canvas-backed duck, American wigeon, shoveller duck, &c. Fishes, also, to the number of nearly forty, representing the resources of the lakes and rivers of Upper Canada, were shown; among which the salmon, herring, &c., representing an export value of several hundreds of thousands sterling per annum, were conspicuous. The salmon ascends the river St. Lawrence for 1,200 miles in order to spawn, and vast numbers are annually taken.

Nova Scotia, also, sent her fish, but well preserved in spirits, such as the mackerel, herring, cod, salmon, hake, flounder, eel, haddock, trout, whiting, &c., and several edible mollusca, such as the solen (razor shell), Virginian oyster, and the great mussel (*Mactra gigantea*); also the enormous American lobster (*Homarus Americanus*), with claws measuring fifteen inches in length and weighing several pounds. In the centre of the court stood a splendid specimen of the largest of existing deer, the elk or moose (*Cervus alces*), said to be the largest stuffed animal in the Exhibition. The horns sometimes exceed 60 lb. in weight, and, as an old writer says of him, "The elk is a monster of the venison sorte; his horns exceed (in weight) all creatures which the New World affords." He does not attain his full growth until fourteen years old, and then reaches a weight of eleven or twelve hundred pounds. A fine pair of horns, also, of the Wapiti deer (*Cervus Canadensis*), decorated this court—an animal resembling in appearance the red deer of Europe. Its flesh is not so highly prized as that of the elk, and that perhaps will prevent its ever being largely domesticated in this country, where it readily thrives. The other contents of this court were chiefly skins from the *barren grounds*, the great source of those furs that are at once the comfort and the bane of the poor animals which yield them with their lives to the civilized luxury of man. In these treeless tracts roam the glutton, the ermine, the bear, the Arctic

hare, and the reindeer, which last stands as "a representative of the verge of realms of ice and snow" beyond. Some of these animals are so pursued, on account of the value attached to their skins, as to be almost extinguished; and the local government of Nova Scotia was unable to obtain a skin of the black fox, owing to the large price paid by the Russian nobles for this favourite fur.

Although, however, the Colonial courts contained the mass of the natural history of the Exhibition, there were many interesting specimens found incidentally in other parts, at which we will, in conclusion, briefly glance. In the Austrian court, Professor Hyrtl's preparations of anatomy and osteology were deserving of the highest praise, and a medal is most properly awarded to him for them. They contained, among other things, a series of the ear-bones of man, and of many mammalia and birds —a monument of the anatomical skill and learning of the preparer, which was valued at £200. Several important skeletons also were by the same professor; among them that of the Chlamyphorus, a most singular creature, of which only one other exists in Europe,—viz., in the British Museum; and as these were both found at Mendoza, in Chili, which has since disappeared, with all the surrounding territory, from the surface of the earth, by an earthquake, which, in 1861, engulfed it with 14,000 souls, it is probable that all the Chlamyphori have been destroyed. This skeleton has been purchased by the Royal College of Surgeons for £40.

Some very fine articulated skulls were shown in the French court, by Guérin, Rue Rouen, Paris; and near them were the remarkable preparations and models of Dr. Auzoux, which also obtained a medal. The doctor terms them preparations of Clastic Anatomy—from κλάω, to break—because his models are composed of solid pieces, which can easily be mounted and dismounted, and are removable one by one, as in a true dissection. He showed a complete model of a man, which could be detached in ninety-two pieces, showing two thousand parts in detail, the price of which was 3,000 francs (£120); also that of a horse, containing ninety-seven pieces, showing three thousand parts. There also were enlarged models of minute parts, such as the ears of mammals, birds and fishes, the larynx, tongue, &c.; and models, upon the same plan, of typical animals, belonging to all the great branches of the animal kingdom, and extremely valuable for educational purposes, though perhaps somewhat expensive, as we should not like to have to give £8 for a leech, or £10 for a snail or a cockchafer.

Some very beautiful wax models in the Italian department, by Drs. C. and S. Calenzoli, also obtain, as they deserve, a medal. They represented the history of the silkworm in all

its stages, and were very extensive and interesting. M. Guérin-Meneville likewise obtains a medal for his labours in the introduction into France of the silkworms of China, India, and Japan, more especially the Ailante silkworm (*Bombyx cynthia*), a hardy species, feeding upon *Ailanthus glandulosa*, a hardy tree requiring little cultivation. It appears that more than a million of these trees were planted in France in 1861, and more than one hundred millions of seed sown, sufficient to cover 50,000 acres. This tree and silkworm are said to have already been successfully introduced into various parts of Europe, Africa, America, and Australia.

Lastly, the Educational department contained many interesting collections and illustrations, by Messrs. Bartlett, Ashmead, Wilson, Damon, Wright, Robertson, &c., who in their different departments of Zoology and Physiology all obtained medals.

We are now compelled to bring this survey to a conclusion. It cannot be said that zoology and the taxidermist's art were badly represented, though doubtless, as in all other things, bad and good were mingled together. The preparation of animals, and their preservation for the museum, is a highly important art, perhaps not sufficiently recognized: it demands at once manual skill, experience, taste and knowledge of natural history, the first being useless if it be not guided by the last. Nothing is more pitiable than to see nature violated by the hands of an ignorant stuffer, as was sometimes the case in the late Exhibition, and false ideas derived from such abortions are more easily received than eradicated. The preparation of animals is certainly an art which is undergoing improvement—more taste is shown in the accessories, more grace and nature are imparted to the form, and more life to the object from which real life has departed; and had all the zoological collections been arranged together, as was the original plan of the Commissioners, a comparison of the different performances of the taxidermist would probably have led to useful results by stimulating the skill and energies of the inferior workmen; but the exigencies of the Exhibition imperatively demanded that everything should be geographically arranged, and it was found impossible to make an exception even in the Natural History department, where it seemed most desirable.

No. VIII.

THE COLONIES.

BY THE EDITOR.

PROBABLY it may be deemed a piece of superfluous information by many of our readers, when we state that the British Colonies occupied, with a display of their natural resources and local manufactures, the north-east transept of the Exhibition building; but it will most assuredly be gratifying to every one, whether or not he may have directed his attention to this department in the World's Fair, to know that it contained unmistakable evidences of thriving industry, active enterprise, and unlimited natural resources.

Let us return in imagination to these attractive courts, as they graced the world's bazar, and cast a hasty glance over their contained treasures.

Whether we inspect the tropical products of India, those of the more temperate regions of Australia, or of the vast Canadian forests, in whatever direction we cast our eyes, we meet with the same profusion of natural wealth that seems almost inexhaustible. But if we consider the application of these gifts of a bountiful Providence, as here represented, we are even more astonished than by the natural products themselves.

Woods—which we had supposed to be applied only to the coarsest uses, the lowly pine for example, associated in our minds with pitch and rosin—we here find polished and carved with such craft that no royal personage need feel ashamed to range the furniture constructed of its planks side by side with his cabinet of satin-wood or maple; and the almost worthless fruit, the "cones," in fact, of an allied tree, which in our own plantations cumber the ground, may here be met with, transformed by the hands of our fair sisters of New Brunswick into beautiful baskets and "what-nots."

Stray we into the court of "South Australia," we find the natural productions of the animal and mineral kingdoms curiously wrought into costly ornaments, which speak of a rapid progress in art and civilization; whilst, at "Natal," the very sea-weeds are utilized and converted into the useful appliances of every-day life.

But we are anticipating, and will now invite our readers to accompany us in a stroll through this department of the Exhibition, during which we will endeavour to point out those objects that recommend themselves to our notice from their rarity, utility, or novel application.

As we enter the north-east transept, and approach the courts of the Antipodes, our attention is arrested by a series of water and oil colour drawings, which not only possess considerable merit as works of art, but representing, as they do, scenes illustrative of life in these remote colonies, and of the dangers to which the settler is subject, may well serve as a frontispiece to our matter-of-fact description of the treasures which are stored in the courts beyond.

Here we find transferred to canvas the sad story of a colonist who during his wanderings in the backwoods has missed his way; "Lost in the Bush; or, a Fern-tree Gully" is its title, which conveys but a faint idea of the incident depicted. In the centre of the picture lies the poor traveller, asleep or dying from exhaustion. His garments are of the most meagre and ragged description, and bear witness of many a weary and painful day's wandering through the "bush." His body is guarded by his faithful dog, an Australian dingo, who keeps at bay the vultures soaring overhead and awaiting the departure of the spirit, that they may pounce upon their lifeless prey. Close to the settler lies his horse, if the miserable collection of skin-covered bones may be so designated; and he, too, is surrounded by a hungry and expectant assemblage, a pack of wolves, likewise held at bay by the faithful dog.

But what a contrast with this picture of misery and death is afforded by the surrounding scene! High tree-ferns and other denizens of the forest, towering aloft in rank luxuriance, are visible on every side; but even these fail to hide the clear blue sky which peers calmly through their branches, as though it were looking down upon some joyous festival or merry-making; and all around we find a calm repose—a natural profusion!

But let us move onward a pace or two, and here we are amongst the "diggers." These are the "Bendigo gold-fields, with the town of Sandhurst in the distance," the Land of Promise, to which so many of our brothers and sisters, lovers and husbands (not always those, by the way, whose absence was to be regretted) have been attracted by dreams of gold. Here we have the gold-seekers' operations brought home for our "private view,"—and what a motley scene it is!

Diggers hard at work with picks and spades—Europeans, Yankees, Chinese, men of all climes and countries. Yonder is the digger's hut, and his lady at the door, attired in the gayest

of colours, and bargaining with, we believe, a travelling pedlar. The different operations of the diggers are well delineated, and the distant town gives excellent effect to the picture.

There are views of other gold-fields; but we cannot stay to examine them, and must finish our frontispiece with another vivid sketch of colonial life.

It is a representation of the "Maories driving off Settlers' Cattle: an Episode in the late War."* Let us endeavour to recall the chief features of the scene.

In the foreground, we have a group of natives concealed in the "bush;" the men are armed with rifles, which they are discharging in the direction of the settler's house; whilst a woman, with uplifted axe and with eyes flashing fire, spurs them on to the conflict. Beyond, to the right, we have the broad cultivated fields of the colonist, through which the Maories are driving away his oxen and other cattle, as well as his horses, ready saddled and bridled for use. Here and there, one of the natives, bringing up the rear of the marauders, turns round to fire at the pursuers. These are not visible on the scene, but the quarter from which they are advancing is indicated by their heavy fire and the rolling clouds of smoke.

It is, indeed, a bold and stirring picture! Yonder, on a slight eminence, is a barn or outhouse which has been set on fire by the plundering Maories; whilst in the foreground, concealing the colonist's party, is a magnificent tree-fern, such as we met with in the picture of the "Fern-tree Gully," and which affords great relief to the various stirring incidents represented in the other portions of the picture.

This is our frontispiece—as presented to us by the colonist himself in illustration of the scenes which characterize his checkered life. Now let us enter his show-rooms and examine the fruits of his industry and enterprise.

The first court to which our attention is directed is that of *Tasmania*, which is completely surrounded by a high wall of polished planks—woods indigenous to the colony. Here we will enter, and examine, first of all, this beautiful cabinet, the material of which offers a rather difficult problem for solution. "Is it of satin-wood or bird's-eye maple?" we ask of the gentleman in charge of the court. It has the mottled appearance of the latter, with the wavy lines of the former. Taking us to the great "trophy" of woods in the centre of the court, the conservator of these treasures shows us, with a smile, a polished plank of the same wood as that of which the cabinet is constructed. "It is the Huon Pine (*Dacrydium Franklinii*), one of the most valuable trees in the colony."

* By W. Strutt.

We need hardly describe our surprise at finding so ignoble a tree converted into so elegant a material; nor is it necessary that we should draw the attention of our English cabinet-makers to this beautiful wood, for our guide told us that several have already bid a high price for the plank which we were examining, and certainly a more beautiful specimen has never come under our notice. The Huon pine, we are told, is used for veneer, and costs in the colony about sixteen shillings per hundred superficial feet.

Returning to cast another glance at the beautiful furniture into which this wood is manufactured, our attention is arrested by various other kinds, of which the planks are of gigantic proportions; and, on expressing our surprise at this, we receive from our conductor the following information:—

"The three most remarkable specimens of Tasmanian wood are too large for exhibition even in this building, but they may be seen in the Horticultural Society's gardens. There may be found planks of white gum (*Eucalyptus viminalis*), blue gum (*E. globulus*), and stringy-bark (*E. giganteus*), varying in length from eighty, ninety, or one hundred feet, to one enormous spar three hundred and fifty feet in height!"

What an idea this imparts of the towering trees which constitute the forests of Tasmania!

The use, we are told, of these descriptions of wood is chiefly shipbuilding, and more especially are they adapted for the "knees" of vessels,* for which purpose their great strength renders them very valuable. Indeed, one piece of "blue gum," in excellent preservation, is exhibited which has been forty-five years in use.

"But what," we ask, "is the use of that great canoe?"

"That is a portion of the paraphernalia of the sperm-whale fishery; and here we have the other appurtenances of this industry: the instruments of destruction, paintings of the ships employed in the trade, the casks in which the oil is stored, the 'head-matter' in a bottle, the teeth and jaws of the sperm whale."

Let us here remark, *en passant*, that throughout the Colonial Courts we could not help admiring the pains taken by the exhibitors to display in a perfect manner the whole of any industry; and we shall often have occasion to notice the completeness with which each has been arranged, to the advantage of those who desired to find in the Exhibition something beyond a mere show, and to the great credit of the exhibitors.

But we must leave the sperm-whale fishery and the huge

* Hickory-wood is the kind employed for "knees."

logs and planks of timber, and pass on to a subject of deep interest in this colony.

"These enormous, blooming apples and pears," we ask, "are they indigenous?"

"They are wax models of fruits which have been introduced from the mother-country, so you may judge of the prolific nature of our vegetation. Our cereals, too, are magnificent." (By the way, to judge from the praises bestowed upon their cereals by the representatives of *all* our colonies, we need never stand in fear of a famine at home.) And, certainly, the specimens exhibited to us fully bear out this designation, for the ears of wheat and Indian corn seem bursting with their contents.

But our time and space will soon be exhausted if we tarry here any longer, so let us glance hastily at these excellent photographs of unprepossessing aborigines; then we will cast a wistful eye over the beautiful jewellery exhibited by our courteous guide, Dr. Milligan,—jewellery which testifies to the wealth of the colony in precious stones; for here we have the topaz, jacinth, cairngorm (magnificent specimens!) crystals, carnelian, garnet, and opal; and let us finally conclude our visit with an expression of admiration at the ingenuity of our Tasmanian brethren in barking their trees and, instead of throwing away the bark, preparing it for the market, and offering it at £4. 10*s*. per ton for the manufacture of paper!

Adieu, now, to Tasmania, and greeting to Victoria,* as we pass through it to the courts of the Australian continent.

Passing on to the *New South Wales* Court, we find several interesting productions of the colony, some indigenous and others introduced and cultivated there. There is, for example, the beautiful maize-plant (*Zea Mays*), standing eight feet in height, and the corn from which is the most conspicuous amongst the different kinds of grain. The other chief products of the soil, of which specimens are exhibited, are wheat, tobacco, cotton, and a collection of woods not second to those in "Tasmania." Here, too, we have handsome pieces of furniture, and one beautiful cabinet, constructed of polished cedar, is remarkably conspicuous.

But the most interesting feature in this court is to be found amongst the animal productions, more especially in the application of that useful animal the kangaroo; and we venture to say that few Englishmen are aware of its full value to the colonist.

* It was in an unfinished state when we visited it, and the description of its contents must be left to abler pens than ours.

Amongst the articles made from its skin only we have here whips, saddles, bridles, and other equipments; boots and shoes innumerable (which command the admiration of all visitors, on account of their excellent workmanship), mill belting, &c. &c.

Silk, too, has been recently introduced into the colony, and the specimens exhibited speak very favourably for its permanent culture.

But what do our manufacturing friends say to the wools; the beautiful specimens of which, both washed and unwashed, merino and alpaca, cannot fail to call forth their admiration?

Lastly, but by no means the least interesting, are the mineral productions, of which we can only notice the gold.

Nothing can be more interesting than the manner in which the precious metal is here displayed in every form and stage of its production and manufacture. First, we have about fifty samples of the various forms in which the gold is found in different parts of the country.* And side by side with these there is an equally interesting collection of earths, illustrative of the different deposits which are met with in sinking for gold in various parts of the colony.

The depth below the surface at which the auriferous deposit is found appears to vary considerably, being in some places (Peel River) close to the surface; whilst in others (Rocky River) it is necessary to penetrate about eighty feet into the earth, through soil, clay, basalt (nodular), and soft sandstone; and the "auriferous drift" is here found to be six feet thick, lying upon a bed of soft granite.

But the colonists do more than raise and wash their gold, as we cannot fail to perceive on leaving the court; for here we have two works of art, valuable not only on account of the material in which they are wrought, but also because of their exquisite workmanship.

They consist of a kangaroo and an emu, about six or eight inches in height (so far as our memory serves), formed of solid Australian gold, and each is mounted upon a kind of pedestal or rock of malachite. The workmanship is, as already remarked, of the first order, and the same observation applies also to other beautiful specimens of jewellery; but our limited space again compels us to leave these treasures, and travelling onward we arrive at the colony of *Queensland*, that portion of our Australian settlements to which at the present time the hopes of our cotton manufacturers are so anxiously directed.

That this is a young colony is manifest from the products and manufactures which it exhibits. No such beautiful cabinet-

* One nugget weighs above thirteen ounces.

ware or jewellery as adorns the older settlements is here to be met with; but the conspicuous articles are raw cotton and wools. Of the former there are several beautiful specimens, some grown from the Sea Island seed, which is equal in value to that imported into Liverpool from New Orleans; and the wool is remarkable for its long silky fibre, and is chiefly from the Mauchamp breed of sheep. The staple of one very prominent specimen of wool is nearly six inches in length.

The woods of Queensland are also interesting, and their uses various; those which are exhibited being chiefly employed in cabinet-making; but, as just remarked, the young colony, although it gives great signs of promise, cannot yet compete with its older neighbours; and we shall now leave it for the purpose of inspecting the contributions of

South Australia. The most beautiful specimens of wheat of any that we have met with in our little tour through the colonies were shown to us in this court. One sample weighed above sixty-eight pounds to the bushel, and the flour produced from it was of unexceptionable quality. Almost as fine was the barley, and more interesting than either, the implement employed for their harvesting. The "reaper" which is exhibited in this court is certainly an unwieldy machine compared with those employed in England (not that *they* are very elegant); but then it reaps, gathers, thrashes, and winnows,—a series of operations in the performance of which our less aspiring agriculturists are satisfied to employ three different machines. This complicated implement is rendered necessary by the scarcity of labourers in the colony; and how it fulfils its various duties we are, for obvious reasons, unable to inform our readers.

If the vegetable productions of South Australia be interesting, equally so are its minerals; amongst which may be mentioned the malachite, of which crude specimens, as well as those wrought into objects of *vertu*, are remarkably conspicuous.

Although not strictly coming within the scope of our observations, we may refer, lastly, to the interesting ornaments formed of emu eggs, beautifully mounted in silver. Two emus in chased silver support the fine ebony-like egg upon their backs, and on the top of the egg stand two natives, also wrought in silver.

These and other similar ornaments speak well for the taste and ingenuity of the colonial artificers; and we could find themes amongst these beautiful articles of *vertu* for many laudatory observations. We must, however, travel on until we get to

Western Australia, concerning which we shall have a word or two to say before quitting this great section of our empire.

The Commissioners of Western Australia have so ably

descanted upon the merits of their contributions,* that we cannot do better than allow them to describe, in their own language, those objects which chiefly attracted our attention.

Of the "Jarrah" tree (a species of myrtle) they say:—

None of the other Australian colonies possesses timber of similar character to the Jarrah, or endowed with equally valuable properties.

The Jarrah is remarkable for its enduring qualities, for its resistance to decay—setting at defiance time, weather, water, the white ant, and the sea-worm. One of the pieces of wood exhibited is a pile from a jetty in the sea at Freemantle, where it remained during a period of twenty-nine years. The lower portion was under water, exposed to the attacks of the sea-worm, which in those seas destroys every other wood in a very short time; the middle was between wind and water, submerged or exposed with every change of tide; the upper portion was always exposed to the action of the weather, to the intense sun of summer, and the long-continued rains of winter.

Another piece of the same species of wood has been buried underground for thirty-one years untouched by the white ant, and which in a few months destroys every other kind of wood so circumstanced.

For this valuable quality, the Jarrah is now much sought after for railway sleepers in the other Australian colonies and in India.

The Jarrah, when better known, will doubtless be found available in the ports and dockyards of the United Kingdom for piles, dock gates, and other purposes for which Hyamised woods have been found inefficient. It is also admirably adapted for keel-pieces, kelsons, and other heavy parts of ship-building.

The pretensions of the wheat, too, fall very little short of that exhibited in "South Australia," one specimen being marked 66 lb. to the bushed; and the reader will not be surprised that such beautiful cereals should be produced in a country the climate of which is thus described in an official report of the Colonial Secretary, 1858:—

I believe that, in general salubrity of climate, Western Australia possesses a marked superiority over any of the Australian colonies. It is subject to no extremes of heat or cold. Cattle have never been known to die from lack of water, and in the very driest weather there is a sufficient supply of food for them. Exposure to weather, by night or day, appears to produce no ill effects on the constitution of the colonists, many of whom, for months together, rarely sleep under any beyond the most temporary dwellings. Snow is never seen; ice only in the depth of winter, and then only in the very early morning. As in New Zealand, both maize and potatoes ripen in this country, and the latter crop is grown to a considerable extent. The apple and the pear, the orange, banana, fig, peach, and apricot, with the melon and

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* Descriptive Catalogue (no publisher named): A. Andrews, Esq., London Commissioner, 2, Church Court, Clement's Lane.

the vine, grow luxuriantly, and may be seen ripening at the same time. The colony is peculiarly adapted to the growth of the vine, on the cultivation of which much attention is bestowed, and which is likely to prove very remunerative. English and tropical vegetables are largely cultivated, and yield profusely. Attention is also being directed to dried fruits; and specimens of figs and raisins that have been sent to the periodical horticultural exhibition for competition are little inferior to those imported from Europe.

Let us now depart from this land of promise,—from this vast field for the enterprising and adventurous; this storehouse of wheat, timber, wools, and gold! And indeed we leave it with regret, for it has filled us with pleasure to witness the boundless resources and growing enterprise of our Australian colonies. But we have still to survey much that is equally interesting; and crossing, therefore, the Indian Ocean (or, we ought rather to say, the north-east transept), we find ourselves safely landed in the island of *Ceylon*, amongst new scenes, new products, and novel ornaments and appliances.

Here we are unmistakably in the Land of Cinnamon; and the most interesting, because the most complete, feature in the Ceylon Court consists of the objects and pictures illustrative of the culture of this plant. This is one of the examples, to which reference has been made, of the care evinced by the exhibitors to render the visitor perfectly acquainted with the whole of any particular branch of industry; for in this case we are, to all intents and purposes, transported to Ceylon itself, to witness the different operations upon a cinnamon plantation.

First, our attention is directed to a series of excellent photographs. One represents a native cutting the cinnamon (and then our guide shows us the tools employed for the purpose); another is that of a native labourer peeling and scraping; a third, sorting and baling; and here we have the cinnamon itself, tied up in bundles very much resembling the sticks round the axe of a Roman lictor. And what sticks! if our memory serves us aright, they are between four and five feet in length.

Lastly, to complete this branch of industry, we have samples of various oils, extracted from the roots and leaves, which are used for medicinal purposes.

Turning to another part of the court, we are struck with the appearance of a number of variegated but handsome walking-sticks, which, our guide tells us, represent the various woods of Ceylon; and amongst them may be found the coffee, cocoa-nut, satin, cinnamon, and a variety of other woods. Whilst admiring these specimens of Ceylon woods, our eye is attracted by the title of the exhibitor, whose name, "A. Mendis, Modliar," is conspicuously printed upon a card; and we are induced to inquire, "What is a Modliar?" "He is a native

officer of the British Government;" and we are shown a photograph of one in his official robes. These "Modliars" are the chief exhibitors. They have sent specimens of oils, camphor, rice, carved-wood ornaments (one gentleman, who stands possessed of the name of Mr. Weiralasirinayana Absyaratine, exhibiting a beautiful piece of furniture of carved ebony), whilst the "Ceylon Committee" contributes the spices for which the island is so famous.

A curious and most valuable substance exhibited in this court, and which is also found in "Queensland," is the oil of the dugong, or halicore, an animal allied to the seal. The oil is white and solid, and is employed for the same purposes as cod-liver oil, viz., as a tonic in cases of consumption, possessing the additional advantage of being entirely free from any nauseous properties, and devoid of taste or smell. It was introduced into England by Dr. John McGrigor Croft; but beyond this we could gain no satisfactory information concerning its history.

But we must now travel northward, crossing over to the continent of India; and in the World's Fair we are compelled to retrace our steps, and, once more traversing the transept, we must mount to one of its galleries. Here we shall find a most courteous and able expositor of the treasures of Inde in Dr. Forbes Watson; and our readers shall have the benefit of the interesting information which he gave us concerning those products of the soil which now, more than at any previous period, possess such a deep interest for our countrymen.

First of all, we are shown a kind of skeleton stand, composed of a series of circular shelves, situated one above another, and in this are ranged 300 bottles, each containing the sample of a different growth of cotton; and Dr. Watson further hands us an illustrative plate, showing the lengths of the staple of cotton produced respectively from "native" seed, from "New Orleans, or American," and from "Sea-Island and Egyptian" seeds.

Next in importance to the cotton culture is that of tea; and here, again, we are shown a variety of specimens, the number being almost incredible.

Dr. A. Campbell, who collected these teas from the various provinces of India, showed us 142 different samples contributed by fifty estates. Of these the most valuable are the "Darjeeling" teas, from the Himalayas, of which 10,000 lb. only have been produced this year; but the exhibitor stated that next year the quantity would, in all probability, be increased fivefold. Dr. Campbell values the finest Darjeeling tea at 2*s*. 8*d*. per lb., exclusive of the import duty.

It is not generally known that the East Indian teas are of very strong flavour, and are chiefly used for mixing with the lower qualities of tea sold to our labouring classes. We, how-

ever, tried several samples which the exhibitor gave us without any other admixture, and they have been highly approved by all who have tasted them.

Amongst the other luxuries (if tea can be so designated) exhibited here, we were much interested in, but not greatly edified by, that of opium in its various states of preparation: "crude ball" opium, "grain," and other forms in which this noxious substance is vended; and, as appropriate companions to this enervating narcotic, we found various intoxicating drinks used by the natives.

These consist of rice and date arrack, rum, and "country spirits," the latter being distilled from the cocoa-nut palm.

But if these alcoholic beverages fail to call up pleasant associations in our minds, we have here two other products of the vegetable kingdom, one of which especially is becoming every day of greater importance to our welfare at home. The first is indigo, of which, along with many other colouring materials, there is a goodly show; and the second, to which special reference must be made, comprises the various seeds used in the manufacture of oils and cattle-cake. The Bombay linseed, of which above 35,000 tons weight were imported into England alone in the year 1861, is the finest in the world, and commands the highest price of any in the market.

To give our readers some idea of the cause of its high relative value, we may just state the following facts concerning it:—Linseed yields two substances in crushing; viz., oil, used for painters' purposes, &c. &c., and the residue being cattle-cake.*

Whilst we write this, the value of linseed oil is £42 per ton, whilst that of linseed-cake is only £11 per ton. It is therefore obvious that the more *oil* obtained from the seed, the more valuable it must be.

Now a quarter of Riga linseed weighs 400 lb., and yields about 94 lb. of oil in crushing, the residue being inferior cake; whilst a quarter of Bombay linseed weighs 416 lb., yielding 132 lb. of oil, and the remainder fine nutritious cake, of considerably more value than that made from other seeds. This explains the increased worth of the Bombay seed. The linseed from Calcutta and Madras is but slightly inferior to that of Bombay.

Again, the finest refined burning rape-oil is extracted from the "Guzerat" rape-seed, grown in the province of that name, and exported from Bombay; so much so, that a considerable

* No doubt all our readers who visited the Exhibition will have seen the seed-crushing process carried on in the Machinery department of the building, by Messrs. Blundell, Spence, & Co., of Hull.

quantity of the so-called colza oil, imported from France and Belgium, is made from the seed originally brought from India to London and Liverpool, and thence re-exported to those two countries. How important must our colonies be to our welfare, when we find that the continental nations which supply us with food for our lamps come to England to purchase, for this purpose, the raw material which is brought from our own distant settlements. Besides the two already named, there are many other seeds yielding oil. Of these the chief are, teel, or gingelly, a small white and black seed; niger, a bright black seed; poppy, ground-nuts, &c. &c. As to the products made from these seeds, if cattle could speak, they would probably tell us that they frequently observe indications of the presence of the inferior cakes made from some of them in their linseed cake; but, as they *cannot*, that will remain a profound secret. We, however, have suspected the presence of the *oils*, which are for the most part colourless, and are largely used in France and the Mediterranean, in the *olive oil;* and wicked persons are in the habit of asserting, in the most barefaced manner, that they are largely employed for the purposes of adulteration.

The mineral products of India are not conspicuous, and the coal, of which there are the representatives of the five different fields now worked, is of inferior quality, and suited only for river steamers.

The specimens of silk, wool, and other animal products, are of the first order; and these lead us into what is, unfortunately for us, forbidden ground.

It does not come within our sphere to speak of the exquisite works of *art* which give such *éclat* to the Indian Court,—of the ornaments in silver and gold; of woven fabrics of such delicacy as to be almost transparent, and which are trimmed with gold and silver lace equally delicate. Nay, the further we venture into this court the more seductive does the exhibition become. These gorgeous ornaments of gold and silver; these caps and crowns, fans and punkahs; this beautiful carved furniture; these richly jewelled and inlaid arms; and such Cashmere shawls, gold-embroidered purses, caps, and slippers! . . . . . but we must proceed no further, and, with a well-merited compliment to Dr. Forbes Watson, for what we consider the most perfectly arranged of all the colonial courts—and that is saying much—we must now bid adieu to the wealth of India, and hasten onward to

Natal. Although we cannot tarry long in this court, we have time to inspect the interesting model of a Kafir kraal, or encampment fortified against wild beasts, and equally wild inimical tribes. Or we may imagine ourselves for the moment to be emigrants, and examine with interest the bush waggon and its appendages.

We may admire, too, the native cap, manufactured of feathers, and exhibited so prominently; and stay for an instant to hear that our colonists have commenced the culture of tea and silk, and that the sugars produced in the settlement are of excellent quality. In passing out, we cannot fail to notice the fine specimens of rhinoceros horns, nor to be struck with the display of native weapons, all of which speak of a population consisting largely of aborigines; and, leaving the colonists to develop their resources and push on the work of civilization, we now hurry onwards to the

Cape of Good Hope. The exhibition in this court is unique, and is calculated to cause surprise to one who has visited the remaining courts in which our colonies are represented; for it consists of a limited display of articles contributed by one individual, Mr. Ghislen.

This gentleman has done what he can to redeem the character of this important colony, which is absolutely unrepresented, wherefore we know not,* The most remarkable, and certainly a novel, feature in Mr. Ghislen's beautiful little museum is the application of seaweeds (algæ), instead of wood or horn, in the manufacture of whips, handles to cutlery, &c. The stems of a marine plant (*Ecklonia buccinalis ?*) are submitted to some hardening process, and then bronzed, painted, or gilt; and certainly they look very attractive when thus treated, and converted into riding-whips, &c.

In close contiguity to the "Cape" court, if it can be so called, is that of the "*Bahamas,*" which deservedly commands considerable attention, from the beautiful shell ornaments contained in it. All our home-made articles of the kind are eclipsed by these exquisite objects, which consist of baskets, head-wreaths, &c., all of a beautifully translucent white. The buds of the flowers are composed of "rice-shells," the leaves of "cup-shells," and the effect produced by this combination surpasses our powers of description. Why do not our English jewellers direct their attention more earnestly to the employment of such beautiful productions of nature as these? They would adorn a royal head, and far exceed in elegance much of the gaudy and fashionable head-gear now in vogue.

Let us once more cross over to the eastern side of the transept which we are exploring, and we shall there find, in close proximity, our colonies of *Trinidad, British Guiana,* and *Jamaica,* which present features worthy of consideration. Anti-abolitionists point to Jamaica as one of the ruinous results of the manumission of slaves; but, for a "bankrupt" colony, we

* As we visited the Exhibition shortly after it was opened, other objects of interest may have been sent over subsequently.

confess that it contrasts very favourably with some of our solvent ones! The most interesting staple is decidedly sugar; and here, again, we find, what we cannot commend too highly nor too frequently—the complete illustration of this branch of human industry in all its various phases:—the sugar-cane; crude sugar, as extracted from the plant; molasses; very many samples of sugar as exported; about ninety samples of rum, and a great variety of liqueurs.

Another very prominent product of the island is the lace-bark (*Lagetta lintearea*), and other similar substances, commercially know as "bast," and employed for tying up cigars and other manufactured goods. But it would be impossible even to enumerate the products of this rich island, for the mention of them would occupy as much space as this article. It asserts its claim to be considered a cotton-growing colony, not only experimentally but practically. Its animal, vegetable, and mineral products are very numerous, the collections of natural history objects deeply interesting, and the Art collection by no means unimportant.

In *British Guiana* we find samples of cotton-wool which have been pronounced equal to the finest Sea-Island; and we could describe much more that is interesting, did we not fear that the patience of our readers is already exhausted by this dry catalogue; we shall, therefore, hurry through our task and bring these remarks to a close.

The contents of the *Canadian Settlements* present every indication of a rising empire. The vegetable products of *Canada Proper* are of the most important and indispensable description. Winter wheat, weighing 66 lb. to the bushel, is shown with no little pride; and the enormous "trophy" of coarse woods sufficiently denotes the flourishing state of a trade which is being largely interfered with by the daily-increasing employment of iron in shipbuilding. This trophy itself is composed of enormous planks of oak, maple, birch, ash, elm, cedar, pine, walnut, cherry, and a number of other kinds, of which the names are almost unknown here; whilst the pedestal of the trophy consists of gigantic blocks or cross-sections of the same woods.

In the *New Brunswick* Court the same woods are exhibited in a very interesting manner. They form the leaves of a book, and are accompanied by the fruit and foliage of the various trees to which they appertain. Here, too, we have a valuable collection of furs, beaver-skins, &c.; and one of the chief attractions of the court consists of the beautiful pieces of furniture, cabinets, "what-nots," &c., constructed by the fair hands of the Canadian ladies, of "cone-work," in other words, with the cones of the fir-tree.

One mineral substance remains to be noticed in detail, and then we have done.

In this court is a most instructive series of samples illustrating the production, by distillation, of "Albertine oil" from Albert coal. We shall endeavour to convey by description some idea of the appearance of this useful substance in its various stages of manufacture.

First, then, we have the "Albert coal," a bright, light coal, somewhat resembling our "cannel." From this, a thick black fluid is extracted, which resembles crude petroleum, a greenish-black oil; this we will call No. 1. The next process, No. 2, leaves the oil solid, like clotted moist sugar; from this is produced No. 3, which presents a totally different appearance: it is a jelly-like mass, of a gold colour, and full of fine needle-shaped crystals. No. 4 is a thin liquid, resembling colza oil, but flowing more like a spirit. No. 5 may be compared to Irish whisky, being a thin straw-coloured spirit; whilst the last process, No. 6, brings us to the refined spirit, not unlike camphine in appearance.

Thus we have glanced cursorily at our most important colonies—have visited, in turn, New Zealand, the various parts of the continent of Australia; Ceylon and India, with their rich tropical productions; Natal, and the Cape of Good Hope; our West Indian settlements; and, lastly, the important districts of Canada.

Our review has necessarily been brief and imperfect, for we have had so large a mass of materials to consider—have observed such numerous indications of increasing wealth and prosperity—that, as we entered one court after the other, we were more and more perplexed to decide what appeared the most likely to interest our readers.

Let us repeat most emphatically, that, with one or two exceptions, the display is highly creditable to the exhibitors: not only evincing a spirit of enterprise, of which, as Englishmen, we should not boast over much, but an increasing intelligence and a progressive knowledge in science and scientific applications, calculated to astonish those who bestow upon them the consideration which they so richly deserve.

Long may our colonies continue to flourish! Long may they remember that this is the mother-country; but . . . (in this wish it is questionable whether we shall command such unanimous approval as in the two preceding) may they soon be sufficiently strong to govern themselves, so as to constitute the independent centres of civilization all over the habitable globe.

THE MISTLETOE AND PARASITIC PLANTS.

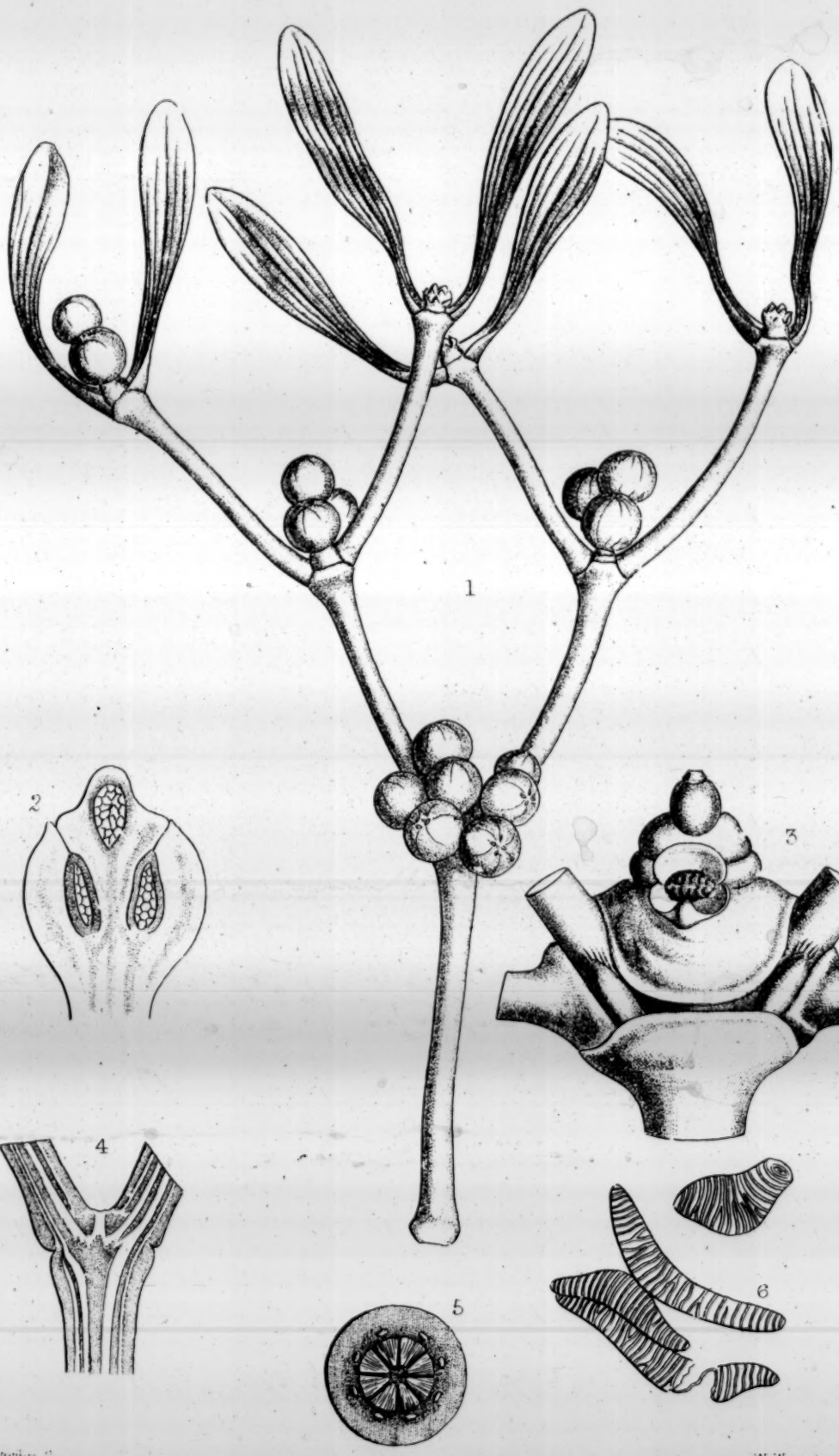
BY MRS. LANKESTER.

BUT few botanists would expect to prosecute their researches in the midst of Christmas fêtes and gambols, and even on specimens rescued from the lurid flame of a burning plum-pudding. Yet we can assure those of our readers whose botanical thirst is impatient for a supply of genuine spring flowers that no more interesting subjects for study can be found in the fields than the holly and the mistletoe—both, perhaps, associated more with the idea of indoor merry-makings than outdoor rambles. Neither are we limited in our botanical studies during the hard winter months, when all Nature seems hiding herself from observation, to these familiar and remarkable plants,—the coloured patches on the barks of trees, on old walls, and broken palings afford a whole world of interesting study; and beautiful collections may be made of these variegated lichens. We, however, select the Mistletoe as the subject for our "winter's tale," not only on account of its great botanical interest, but from its ancient and curious associations with the history of our country.

The Mistletoe, *Viscum album* (Plate VIII., fig. 1), may be regarded as the type of parasitic plants generally—of those plants which establish a habitation for themselves in the substance of some other plant, and live and flourish on nutriment drawn from this source.

The order *Loranthaceæ*, to which the Mistletoe belongs, and of which it is the only British representative, consists almost entirely of parasitic plants. But three genera are known in Europe. *Nuytsia floribunda*, an Australian plant, forms an exception to the parasitic nature of the species, and is a very beautiful shrub, with large bright orange-coloured flowers, which gain for it the name of *fire-tree*.

In describing the order *Loranthaceæ*, we find that some botanists have separated a number of plants once included therein, and established another order, *Viscaceæ*, of which *Viscum* is the type; *Loranthus* being that of the original order, *Loranthaceæ*. This distinction is not very generally adopted, and we are safe in regarding our mistletoe as belonging to the family



J.B.Sowerby, del.

W. West, imp.

Mistletoe.

Loranthaceæ. The plants of this order have articulated opposite branches, leaves without stipules, and flowers in which the pistils and stamens are usually separated. The calyx is adherent to the ovary, with two bracts at its base, and the corolla consists of four or eight more or less united petals. The stamens are four or eight, opposite the petals. The ovary one-celled, with one erect ovule.

On examining a branch of mistletoe in the hand, we observe the long spreading stems of a yellowish-green colour, with somewhat thick, fleshy, long-pointed leaves, having veins running evenly along their entire length, most evident on the under surface. In the axils of these leaves, or the angle from which they spring, as also at the point where the spreading stems meet, we see, in the autumn of the year, a minute flower-bud—insignificant enough to look at, but of such interest, when examined botanically and carefully, as to have afforded matter for elaborate and beautifully-illustrated papers, which are preserved by the learned societies of this and other countries.

These flowers are divided into staminiferous and pistiliferous ones (figs. 2 and 3). The structure of these organs is very curious, and can scarcely be fully described in a few words, for authors differ as to the appropriate names and real functions of the parts. Schleiden, the great German botanist, supposes that the so-called male flowers consist of nothing but anthers; while Decaisne, of whose beautiful drawings in the Transactions of the Royal Society of Brussels we have, in a measure, availed ourselves, contends that the male flowers consist of four anthers grown to the surface of four calycine sepals. They grow on distinct plants from the female flowers, which are botanically the most interesting, as well as popularly, from the fact of their producing the beautiful white berries so characteristic of the mistletoe. The ovule at the base of the female flower does not appear at all until after the pollen has been shed from the anther in the male flower and has entered the little canal leading to the ovarium. Some weeks, or even months, after this has taken place, the little ovule or future seed makes its appearance, and, meeting with the pollen, commences to develop. At the same time, the viscous tissue, of which the fruit chiefly consists, begins to appear, and the tiny seeds are produced, which remain inclosed in their sticky, glutinous cradle until fully ripened and ready to reproduce their own kind. The fact of the ovule being produced after the pollen has exercised its influence is a curious deviation from the usual mode of development in plants. The structure of the woody tissue of the plant is also singular (fig. 4). Decaisne describes it, when young, as consisting of eight woody bundles surrounding a green pith (fig. 5); in these bundles are no spiral

vessels, but instead, and in the place where they usually occur, are found some ringed tubes (fig. 6), together with some dotted or reticulated cells and fibres. On the outside of these bundles of woody matter, which form the longitudinal tissue of the plant, are found others, similar in number but smaller, and composed exclusively of fibres of the inner layer of the bark.

To trace these appearances a careful microscopic examination is required, and some of the more delicate observations cannot be conducted without first submitting the portion of stem to a saturation of spirits of wine.

The manner in which this curious plant establishes itself in the tissue of other plants is very remarkable, and has been well described by De Candolle in his excellent "Physiologie Végétale." Old botanists believed that birds, feeding upon the berries, and getting their beaks surrounded with the viscous matter they contain, rubbed their beaks against the branches to get rid of it, and thus introduced the seeds to their resting-place. Paley, in his "Natural Theology," gives at great length his views of the subject, and says :—

> Of no other plant can it be said that the roots refuse to shoot in the ground, and no other is known to possess this adhesive generative quality when rubbed on the branches of trees.

Careful botanists who have examined the process of growth in these plants from their earliest stage, tell us that from whatever cause the seeds are brought in contact with the wood of the tree on which they establish themselves, they adhere by means of the glutinous substance in which they have been embedded, and which hardens into a sort of transparent glue. Then two or three days after application the tiny radicle may be seen pushing towards the support, whether it be on the under or upper surface ; reaching this point it becomes enlarged and flattened. It now has the appearance of a sucker, and by degrees penetrates the bark. This operation requires some time, and is not completed until the plumule begins to be developed. By the time the young plant has a pair or two of leaves, the attachment will be found tolerably firm.

Mr. Grifiths, who has written a paper on the Orders of *Loranthus* and *Viscum* in the Transactions of the Linnæan Society, tells us that on cutting away a portion of the branch on which the mistletoe had fixed itself and laying bare the included portion of the parasite, he found that the union had taken place entirely between the ligneous systems of both ; the fibres of the sucker-like root of the parasite expanding on the wood of the support in the form of a web foot. There was, however, no interchange of structure between them, neither at this period was there any intermixture of ligneous

fibres. As the parasite increases in size, and an additional supply of nutriment is required, lateral shoots are sent out from the surface, which also penetrate the bark, and are precisely similar in mode of attachment to the original seedling shoot. It is a curious fact that the fibres of the later shoots never penetrate further than those of their primitive attachment. In the adult plants the sucker-bearing shoots frequently run to a considerable distance; many of the stocks being literally covered with parasites, all of which have sprung from one seed. Mr. Griffiths says:—

> I have seen such shoots, which had taken their course along a decayed branch, become reflexed and return in quest, as I may express it, of a part capable of affording nourishment.

The remarkable exception which the viscum presents to the general law—that the radicle or root of the embryo shoots downwards and the plumule upwards, under all circumstances, has been confirmed by curious experiments. So certain is it that the radicle of the mistletoe will turn itself towards the body to which it is attached, whatever may be the position of that body with respect to the earth, that a cannon-ball, to which mistletoe seeds were glued on all sides, and suspended in the air, became the point of attraction for all the little radicles to direct themselves towards from all sides of the ball. This property insures their growing upon the branches of trees to whatever side they may happen to adhere. It is asserted that a branch of mistletoe, if placed in water, has no power of absorbing this fluid itself; but that when the branch to which it is attached is immersed, then the water is readily absorbed and penetrates into the mistletoe. The following experiment was performed by De Candolle. He immersed the branch of an apple-tree, bearing mistletoe, in water previously coloured red with cochineal, which, penetrating the wood and inner bark of the apple-tree, entered into the mistletoe, when its colour was even more intense that in the former. It would appear as if these parasitic plants had an eliminating power, for it is certain that they do not attach themselves to all trees or shrubs indiscriminately. Mr. Griffiths thinks, however, that they would grow on almost any plant whose duration is sufficiently long to allow them to establish themselves. Plants with milky juice seem to be an exception. The seeds of *Loranthus* have been seen to germinate on a frond of *Polypodium*. The influence these parasites have on the stock is according to their respective proportions. If they attack a small or weakly tree, they injure it, and perhaps kill it; but when they attack large vigorous trees, no ill results seem to follow.

The mistletoe is the only green parasite in this country; and often forms a conspicuous feature in the physiognomy of vegetation on the leafless trees of winter. It chiefly abounds on the apple, the pear, and plum tree; and I have also seen it on the poplar. Some authors say it grows on the silver-fir tree; but instances of its attacking the Coniferæ are very rare. Occasionally it may be met with on the oak, but its very unusual presence on this tree has probably much to do with the peculiar reverence with which plants found in this situation were regarded by our early ancestors, and their priestly advisers the Druids. In warmer countries, where the Loranthus grows, its scarlet flowers form a most brilliant contrast to the dark green leaves of the plant by which it is supported. In Chili a leafless Loranthus covers with a scarlet carpet a large candelabra-like cactus, whose snow-white flowers, eight or nine inches long, project from it, and present a beautiful object to the eye.

Parasitical plants, properly so called, are very numerous in the vegetable kingdom, although the species of *Loranthus* and *Viscum* alone have green leaves. There are parasites which live externally on their victims; others which are insidiously introduced into the interior, where they flourish until they pierce through the skin, come in contact with the air, and disseminate themselves. These are known by the various names of mildew, rust, smut, brand, &c. Those which attack externally assume different forms, and have either ordinary green leaves, as in the mistletoe, or brown scales and colourless stems. The brown scaly parasites attack the roots of plants, and their underground habits have caused them to be little examined. The most common species in Europe are the various kinds of *Orobanche*, broom rape, which attack hemp, clover, lucerne, and many other plants; and the species of *Monotropa*, birdsnest orchis, and *Lathræa*, tooth-wort, which infest the roots of the beech, the fir, and the ash. The best account of the manner of growth in brown parasites is given by Mr. Bowman, who studied with care the habits of the *Lathræa squamaria*. One of the most remarkable peculiarities of such plants is the constant absence of all green colour, though exposed to the strongest light. Connected with this is another curious property, that of resisting the attraction of light, towards which all the green parts of a plant irresistibly turn.

The Dodders also are true parasites, although they do not, like the mistletoe, plunge their roots into the wood and incorporate themselves with the tissue of another plant. Yet they twine themselves around the branches of trees, and send out suckers, which, becoming firmly attached to the bark, attract a sufficient amount of nutriment to support their tissue.

The dodders belong to the natural order *Cuscutaceæ*, and there are five species of dodder in Great Britain. The common English dodder is a white or reddish-looking annual, which spreads itself like a mass of living threads around branches of heath and furze, on dry wastes and commons. Unlike the mistletoe, the dodder springs originally from the ground, and when its little plumule first emerges, if it find no living plant near on which to graft itself, it withers and dies; but if there be one within reach, it surrounds the stem in a very little time, and henceforth lives by its suckers only on the fostering plant—the original root in the ground becoming obliterated and dried up. One species of dodder especially attacks the flax-plant; another the clover; and but lately in a meadow in Sussex, I saw most curious-looking masses of this clover dodder. It had attacked the growing clover in patches, which assumed the form of large rings or circles, and at a little distance it looked like carefully-arranged heaps of burned leaves or sea-weed; it was not until after close inspection that I discovered what this strange appearance was, and how terribly this intrusive plant had injured and despoiled the clover on which it throve. These parasites are very injurious to the plants they attack, depriving them of their nourishment and strangling them in their folds. Mr. Griffiths speaks of a gigantic species in Affghanistan, which even preys upon itself, and which half-covered a willow tree twenty or thirty feet high.

Of False Parasites or Epiphytes, as they are called, we have numbers of familiar instances in Great Britain. They generally fasten themselves in the crevices and hollows of the back of trees, and afterwards affix themselves so firmly, that they can only be torn away with considerable force. Lichens and mosses are of this kind. In humid atmospheres and in damp districts they are abundant, but in the warm moist woods of tropical regions they form a most striking feature in the landscape. On a single tree may be found such a number of different parasitic plants, as would cover a large space if planted in the ground. The Pothos plants then become parasitic and grow on the boughs of the loftiest trees, through whose foliage the large white flower rises. Strange Orchidaceæ and Bromeliæ, imbibing nourishment from the atmosphere, grow in the angles of the branches and fill up every crevice in the bark of the tree. The prettiest ferns, like our Lycopodium and Ivy, twine up on the surface of the trunk, while silver-grey Tillandsiæ hang from the branches; not to mention the multitude of climbers, which, once rooted in the earth, have ascended the trees and continue to flourish there when not a trace of their root remains. The long shoots of these plants

often stretch from one tree to another, sometimes hanging like cords, more or less obliquely down to the ground, with not a single leaf for a distance of twenty or thirty feet—these serve for the monkeys and wild cats to clamber on. The parasitical vegetation of the tropics is wonderful in beauty and extent. The Orchidaceæ and Aroideæ are the most common on the barks of trees, and these in their turn are covered with parasites. As in the animal world so it is in the vegetable, every creature has its dependent parasite. We may be excused for quoting a not very elegant, but an expressive couplet:—

> Large fleas have little fleas upon their backs to bite 'em,
> And little fleas have lesser fleas, and so *ad infinitum*.

Microscopic examination alone can reveal to what extent this law of mutual dependence is carried out in every living form. It is not only, however, in living vegetation or animals that we discover parasites. Several kinds are known to exist alone on dead organic bodies. The decaying trunk of a tree affords numerous examples of this sort of parasite, and the German botanist Schmid distinguishes wall, ruin, roof, plank, and rubbish plants. Others of the fungus kind grow only in the strangest situations: such as on wine-casks, in window panes, and on paper. But it is impossible to enlarge on this attractive subject, which would form a paper of itself, whilst we have our branch of Mistletoe for a text waiting for further notice.

The fact that this curious plant is bright and green when all Nature is wrapped in her winter mantle may account for its constant association with Christmas festivities and decorations. Then it has the attraction of association with bygone times and ages. Christmas itself is not now what it used to be in the days of the old Tudors, who, with their maskings and revellings, seem to us somewhat coarse in their boisterous merriment. With our increasing refinement we have lost perhaps some of the spirit of the season, and we believe almost the only relic of the ancient license of the occasion lingers still in some remote country-houses, and in the servants' halls of the present time. John still thinks himself at liberty to kiss Mary under the mistletoe, and the overhanging shadow of the mysterious plant saves Mary's blushes. The superstition connected with the mistletoe is in its character something like that which surrounds the four-leaved shamrock. St. Patrick's touch sanctified the one, and the association of the other with our country's earliest priests—the Druids—has hallowed its history. The doctrines inculcated by the Druids were, in many respects, far in advance of the people by whom they were surrounded. They regulated all religious services and

were the ministers of many things, both secular and sacred. They worshipped many of the Roman deities, and regarded the oak as a sacred tree. Under its shadow they performed most of their sacrifices, and no religious ceremony was entered upon by them without wearing a garland of its leaves. The mistletoe growing on the oak received from them the same homage as the tree itself. The ceremony of cutting the mistletoe from the oak is described by Pliny, and seems to have been the occasion for a great religious festival. It took place as near the 10th of March in each year as possible, and was performed by the Arch Druid himself, who, having tied two white bulls to the tree by their horns, then mounted the tree, clothed in white, and with a knife of pure gold separated the mistletoe from its parent tree, which was received in a "white sagum," or cloth made of wool; this done, the bulls were sacrificed, and they proceeded to the further observances and feastings. Our own national custom of decorating our churches and homes with mistletoe at Christmas time may be a remnant of this old superstition. Moreover, it would appear that the Druids were the medicine-men of the time, and in their prescriptions the mistletoe was a frequent ingredient to be taken with incantations. Pliny tells us they had a name for it equivalent to *All-heal*, and it was esteemed peculiarly good in epilepsy or falling sickness. This reputation does not seem to have disappeared with the Druids; for, although some of the ancients looked upon the mistletoe as poisonous, the old herbalist Gerarde, in 1636, gives his opinion as quite the reverse, and says—

> A few berries of the mistletoe, bruised and strained into oile and drunken, hath presently and forthwith rid a grievous and sore stitch.

He also quotes Galen, who says—

> His acrimony overcometh his bitterness, for if it be used in outward applications, it draweth humours from the deepest and most secret parts of the body, spreading and dispersing them abroad and digesting them.

We are inclined to think that the imagination of the patient had more to do with the efficacy of the mistletoe plasters, as it has with many modern and still favourite remedies, than any virtue in itself. The only practical use to which we now apply the berries of the mistletoe is in the manufacture of birdlime.

Much discussion has taken place as to whether the Loranthus or *Viscum album* was the true mistletoe of the Druids. To my mind there can be but one conclusion in favour of the latter. Loranthus does not naturally grow in Great Britain, and the true mistletoe, *Viscum album*, as also

its fostering oak, are strangers in the land where Virgil sang of the golden bough which formed Æneas's passport into the infernal regions. His bough was undoubtedly one of Loranthus, not of our own true British mistletoe. May we never cease to find it green and bright on our orchard and forest trees, though they be leafless and bare, adding to the delight of our winter walks and our household merrymakings, and may every reader of this little paper henceforth find in a spray of mistletoe a deeper interest, both scientific and historical, than he has ever done before.

Fair Plant, a mystery thy birth,
Thou dost not fix thy home on earth ;
Rock'd by the winds, fed by the shower—
Thy cradle is an airy bower.
No voice of crime in thy leafy dome,
But the songs of birds to cheer thy home,
From the wildling crab this branch was riven
From waving in the breath of heaven.
Alas, alas ! they have brought it low,
To the dwellings of care, and pain, and woe.

PROFESSOR HENSLOW.

EXPLANATION OF PLATE VIII.

Fig. 1. Branch of mistletoe, in fruit.
Fig. 2. Vertical section of an antheriferous or male flower.
Fig. 3. Female flower in the axils of the leaves and branches.
Fig. 4. Vertical section of a branch two years old, showing the tissue.
Fig. 5. Transverse section of the same branch.
Fig. 6. Vessels forming the ribs or nerves of the young leaves.

THE WINTER LIFE OF PLANTS.

BY HARLAND COULTAS.

THE Winter landscape is now spread before me. Every day the field of white snow-drifts which caps the Northern portion of our globe is extending at its circumference. The trees are deprived of their summer foliage, and the race of hardy evergreens appears to advantage. Only here and there a solitary late-blooming flower may be seen, and this at last disappears under the white snow-covering. Nature appears to be devoid of life, as though her pulse had ceased to beat; and we are almost ready to imagine with the poet that the snowy mantle is a pall or winding-sheet thrown over her inanimate and motionless form. Never was there an idea more erroneous. The same formative laws which give to the falling snow-flake its beautiful crystalline forms still operate in the plant-world.

We must, however, except the vegetation within the Arctic circle. The people there never see the sun for months, and without his influence the vegetable machinery will not work. It is, therefore, probable that the Polar plant-world, in all its forms, is in a complete state of torpor and inactivity in winter, during the sun's absence.

But, in lower latitudes, where the sun continues for a few hours above the horizon in winter, his rays are always diffusive of life, however obliquely they fall on the landscape. In all the lower forms of cryptogamic plants there is a considerable amount of active vegetation going forward. Mosses, liverworts, and lichens are very retentive of life, and will grow at very low temperatures—even beneath the snow and ice with which they are covered, provided it is not too deep, so as to prevent the light from getting access to them. Many mosses and liverworts ripen their sporangia or come into fruit in winter. And, as for the lichens, winter is their vegetating period. In summer they are torpid and inactive. Lichens have been very appropriately named by Endlicher, *Protophyta*,*

* The term *Protophyta* is now, strictly speaking, applied to the very simplest plants, such as *Protocœcus volvox*, &c. &c., and not to the Cryptogamia.

or first plants; because they are the very first plants which gain a foothold on the barren rock, and, dying there, prepare the way for a higher vegetation. At this season of the year, when the landscape is no longer decorated with flowers, the moss- and lichen-covered rock has a peculiar interest attached to it, of which it is deprived in summer. There grows the vegetation of winter; and our attention is no longer turned away from these lowly protophytes by the more gorgeous and showy plants which surround them in warm weather.

All the year round there is ceaseless activity in Nature. Plant-life never expires. Even in the depth of winter, there is much organic beauty abroad. Choose your time judiciously, when the sun is up and the weather is clear and frosty, and, if the snow is not on the ground, you will find good botanizing even in winter, if you attend to mosses. You will find these plants almost everywhere. On rocks, fallen trees, on the banks of rivulets, or on the surface of the stones in their pebbly beds; and, if you have a microscope and "Hooker's British Mosses," where these minute plants are most beautifully figured, you will be at no loss for amusement.

But the active portion of vegetation is not wholly cryptogamous. In the strongest January frost, the trees of the mountains—the noble and hardy firs and pines—ripen their seeds. These trees abound in resin, and maintain their temperature above the freezing-point even in the severest weather. Their fluids are never congealed, owing to their viscidity, and they can, therefore, resist the cold. The sap continues to ascend in them, although its upward flow is very considerably diminished.

There appears, also, to be some continuance of vital activity amongst the evergreens which bear true leaves—such as the ivy, laurel, and holly. From the very nature of things, these plants must change their leaves; but they do it in a less rapid and visible manner than the deciduous-leaved trees, one leaf replacing the other in such a way that the tree is never totally deprived of foliage. In the spring of the year there is a partial leaf-fall from the branches of evergreens. The leaves of these plants are more or less in action during winter.

A low degree of warmth will, even in the depth of winter, start the sap of plants. Thus, if incisions be made into the stem and branches of a young maple in winter, if the weather should become mild, the sap will be seen to trickle from the wound.

As a general rule, however, winter is a state of repose to all the higher Phanerogams, or flowering-plants, the only really active portions of vegetation being Coniferæ, Evergreens, and the lower orders of the Cryptogamia. Yet, even if these higher

flowering-plants manifest no active life-processes during their winter's slumber, one process is as absolutely necessary to their preservation as to their growth—there must be an interchange of matter between the air and the body of the plant. This exchange may be small, but it is more than probable that it to some extent exists; for it is a law of plant-life that it can only exist so long as evaporation and breathing are carried on. In winter the inside of a tree, examined with a thermometer, shows a higher temperature than that of the surrounding atmosphere, and this warmth is a proof of vital changes. Although in the development of most deciduous-leaved trees and perennial herbaceous plants, winter is a state of rest, yet they retain their vital properties, and it is no more a state of *absolute* inactivity than the healthy sleep of the animal body, with which this winter's repose of vegetation may be very properly compared.

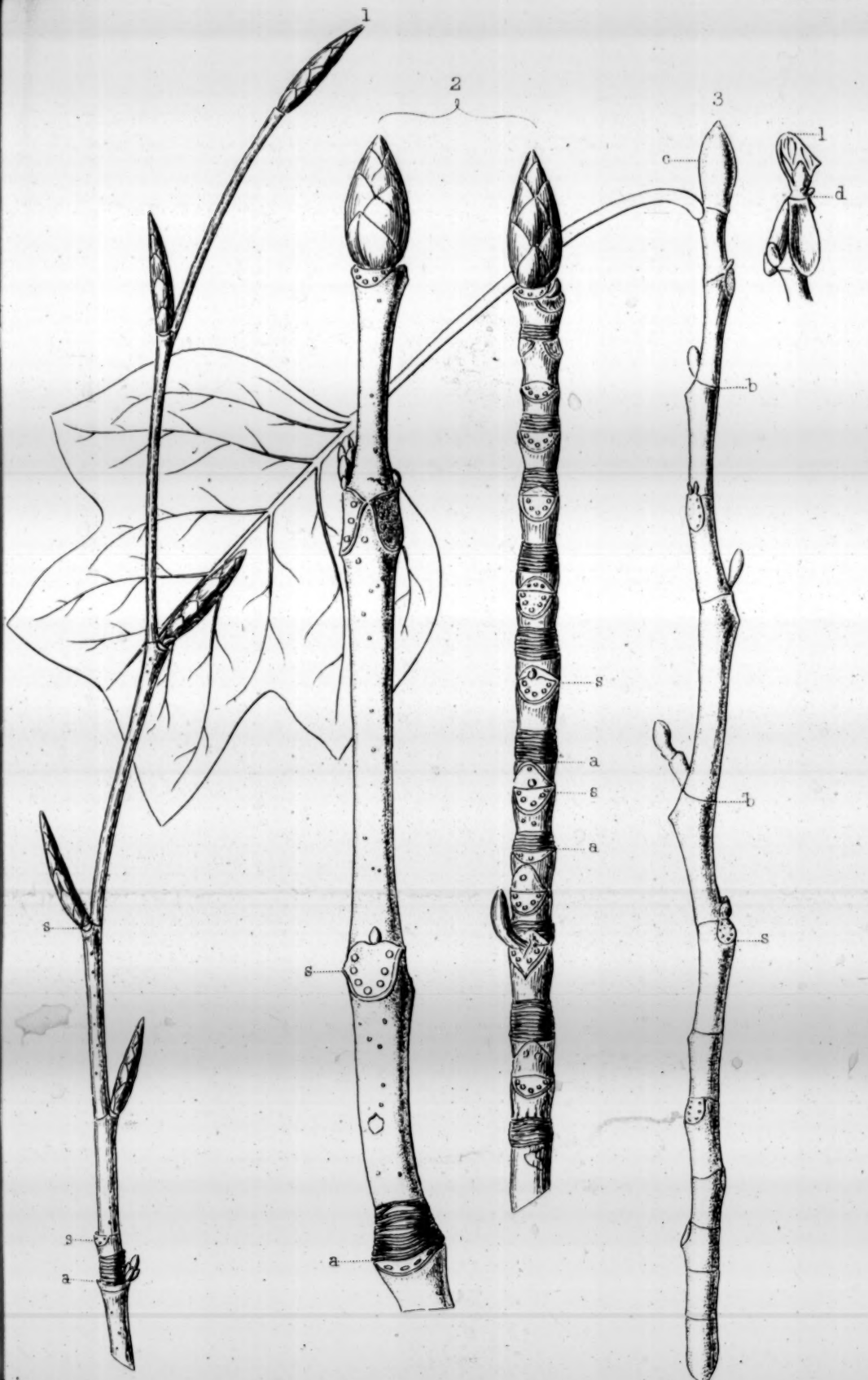
Even those trees which are apparently devoid of foliage, still possess leaves. We refer to the scales or covering leaves which constitute the outer envelopes of the buds. These are the winter leaves of trees, and each tree has them quite as characteristic of its species as its summer leaves. That the scales of buds are only modified leaves, every botanist will readily allow. In many plants the transition of the bud-scales into ordinary green leaves is well marked; and that they are varieties only of the same common leaf-forms, is also indicated by their spiral arrangement, and by the fact that they are alternate or opposite in position about their rudimentary axis, exactly as the leaves may happen to be arranged on the fully developed shoot. These bud-scales or covering-leaves must be regarded as the very lowest type of leaf. They begin to form in spring, and continue growing through the whole of the summer. During the active period of vegetation the current of sap is diverted away from them by the summer leaves, so that they cannot make much progress. In autumn the sap gradually ceases its flow towards the summer leaves, and its last movement, before it stagnates in the tissues, is probably to these winter leaves or bud-scales; for it is then that the buds are matured, just before the trees shed their summer leaves in autumn. Hence physiologists have very properly designated as autumnal sap this peculiar flow of the stagnating nutritive current. The winter leaves being formed under such circumstances, are necessarily circumscribed to the smallest space, and as they do not take the conspicuous forms of the summer leaves, they escape vulgar observation.

These winter leaves of trees, so apparently insignificant, will, however, richly repay investigation. The tree requires protection, not nutrition, in winter, and these leaves are organized

for that purpose. They are devoid of chlorophyll or leaf-green, and without pores. In some instances their surface is clothed more or less densely with hairs, or it is covered with glands which exude a copious resinous or glutinous secretion, with which the surface of the bud is overspread. These leaves are thus organized in order that they may protect the next year's foliage, blossom, and fruits. All the beauty and glory of the vegetation of the coming year is left in the charge of these inconspicuous bud-scales or winter's leaves; for every leaf and blossom is already formed and securely packed away into the smallest possible space in these buds, under the air and water-tight roofs formed by them. In order to verify these facts, it is only necessary to dissect one of these buds, by removing its scales, and examining the embryo leaves in its interior with a microscope. The bud of the horse-chestnut is one of the best that can be selected for this purpose. The embryo leaves will be found in the interior of this bud, in a warm bed of tomentum or down, packed away securely for the winter.

The winter leaves or bud-scales continue attached to the trees throughout the winter months; but when spring comes, and the summer leaves which they have protected are pushed out into the air, the tree shakes off its winter leaves on the green grass carpet, exactly in the same way as it does, later in autumn, its summer leaves. So from all the trees of the forest there is every year a double leaf-fall. The fall of these winter leaves is beautifully seen in the beech, maple, and horse-chestnut; and, as we have already remarked, an observer of nature will experience no little gratification in studying these little obscure though important folioles. The bud was called by Linnæus the *hybernaculum* or winter-quarters of the shoot; and buds with the winter leaves on their exterior may also be regarded as their winter defences. The winter leaves are organized to protect the life slumbering in the buds against the cold of this season of the year. A low temperature appears to be necessary to their life, for as soon as the warm days of spring commence and the summer leaves come out, they fall from the tree. These winter leaves cannot, therefore, live under the same circumstances as the summer leaves; and the winter atmosphere in which they live and discharge so faithfully their protective duties to the summer leaves would destroy the life of the latter.

As the summer leaves make on the stem a cicatrix or scar which shows their former point of union, so with the winter leaves; these also leave their mark or scar; only in this instance, the internodes or naked intervals of stem between the leaves are suppressed, the scars are necessarily close together, and



J.F. Sowerby, Sc.

W. West, imp.

Winter life of Plants.

form a series of annuli or rings, for which botanists have no name, and which we have ventured to call (*gemma vestigia*) vestiges of buds. Whenever these rings are found on the bark of young shoots, they show the position of the winter leaves and the terminal bud of the season,—in fact, the point where the growing shoot entered on the stage of rest. Hence the interval of shoot between two sets of bud-rings shows one year's growth; and therefore the number of sets of annuli shows the age of the shoot.

The reader will better understand our meaning if he will look at the plate which accompanies this paper.

Plate IX., fig. 1, represents one year's growth of the beech-tree (*Fagus sylvatica*), with five buds and their spirally arranged scales or winter leaves. The cicatrix or leaf-scar *s*, left by the summer leaf, is visible at the base of each bud; and the annular scars left by the winter leaves of the previous year are to be seen at the base of this shoot, marked *a*.

These parts are more conspicuous in fig. 2, which shows two shoots of the horse-chestnut tree (*Æsculus hippocastanum*), one the growth of a single year, the other the growth of ten years; yet both shoots are nearly the same size. We have placed them together for the sake of comparison.

The leaf-scar *s*, left by the nutritive summer leaves, is very large in the horse-chestnut, and on its surface are seven black dots, the broken ends of the fasciculi, or bundles of woody fibre, which, uniting together, form the leaf-stalk, and, separating again at its top, form the costæ or midribs of the seven leaflets. This tree derives its popular name from the resemblance of its leaf-scar to the shoe of the horse, those black dots corresponding with the nails in the shoe!

In the ten years' shoot it will be seen that there are on the scars of the summer leaves only five dots; consequently there were only five leaflets to each leaf. The contrast between the broad open scar left by the summer leaves and the contracted ring-like scars of the winter leaves, is in this instance very striking. It is also evident that the vegetative power of the ten years' shoot was ten times less each year than that of the one year's shoot; because it has taken this shoot ten years to make a growth equal to the growth of the one year's shoot. As the growth of the shoot depends on the matter derived from the leaves, and as in this case very little was supplied, the shoot itself is cylindrical, not conical, like the one year's shoot.

Fig. 3 is a twig of the tulip poplar (*Liriodendron tulipifera*), one of the forest trees of North America. The leaf-packing in this bud is peculiar and interesting. *c* represents the closed stipular bud; *d*, a stipular bud opened, with the two stipules reflected downwards, to show the inverted position of the

lamina or blade of the embryo leaf *l*, the two sides of which are folded together and which is bent downwards on its petiole. Behind is another stipular bud consisting of two stipules inclosing another inverted embryo leaf. Further dissection reveals other embryo leaves on a constantly diminishing scale of architecture, *b*, the linear mark on the shoot, or scar made by the stipular leaves, which are, in fact, only another variety of winter leaves. There are seven dots on the leaf-scar.

These shoots were collected in autumn. The *Liriodendron tulipifera*, which is a deciduous-leaved tree, has still attached to its apex one of its leaves, which is purposely left there, in order to give the reader a correct idea of its peculiar truncated form, and also a clear view of the embryo leaf *b*.

The lower and less developed herbaceous plants have also a winter's life and an appropriate shelter for that life, as well as the trees. The seeds of annuals and also the rhizomes, or underground stems of perennials, like the buds of trees, are only so many winter retreats into which the exhausted life of these plants retires for protection, repose, and recuperation during the winter months. "Seeds and resting-spores," says Henfrey, "are organized in a manner especially adapted to preserve their latent vitality from injury by external influences. They can withstand great variations of heat or cold, especially in the absence of moisture. Most seeds will bear a temperature very far below the freezing-point if kept dry, and many will bear an exposure to 100° or 110° Fahr. in dry sand. Prolonged immersion in water at 120° kills most seeds unless the skin is very thick and they contain oil instead of starch in their endosperm."

The seeds of the Whitlow-grass (*Draba verna*), of the different species of chickweed (*Cerastium* and *Stellaria*), of the fumitory and corn-cockle, are sown early, and are, therefore, exposed to the excessive heats of summer as well as to the cold of winter, and yet they come up at their appointed season. So carefully has Nature prepared the seeds of these plants for the vicissitudes to which they are exposed! *Draba verna*, for example, is never scarce. This plant is quite common in Pennsylvania, as well as in England. There is no flower which has interested the writer more than this lowly annual. It is one of the least developed of all the Cruciferæ, whether we consider its leaves, whose vegetative power is so enfeebled that they do not form a sufficient amount of stem to separate them from each other, but remain in a stellate cluster on the ground; its tender capillary scape, or flower-stem, which only rises to a height of from one to three inches above the ground; the two or three small white flowers which that scape supports; or the brevity of its life,

for it comes up in March, and by the close of April has matured and scattered its seeds. Yet these minute seeds, with their microscopic rudiment of a plant, are mixed with the soil, from which they cannot be distinguished, and after lying exposed alike to the heat of summer and the cold of winter, germinate again at the appointed time on our rocks and old walls. In Pennsylvania, where the extremes of heat and cold are much more severe than in England, *Draba verna* grows profusely, and the writer has seen the gneiss rocks about Philadelphia positively overspread with whitened patches of this little plant, towards the close of the month of March.

But the greater portion of the herbaceous plants are perennials, whose leaves and flowers annually die down to their rhizome or underground stem, and, therefore, disappear like the annuals from the earth's surface in winter. But life remains in the rhizome, and the next year's growth is contained within the buds on the surface. The soil in this case shelters the buds. Hence, as soon as the frost is out of the ground, the plants which have been thus protected, issue forth from these subterranean buds, push up through the soil into the atmosphere, and again unfold their leaves and flowers on the same spot. Perennial plants, having the rhizome and bulb as a means of self-preservation, as might be naturally supposed, are not so prolific in seed as annuals.

The period of seed-rest or vegetable torpor may be prolonged for years, if there are not the conditions necessary for germination. For sixty years a bag of plants supplied the "Jardin des Plantes" annually with sensitive plants. Lindley mentions the germination of raspberry seeds, found in 1834, in an ancient barrow (*tumulus*), near Maiden Castle, along with coins of the emperor Hadrian. The seeds were found in a coffin thirty feet below the surface, and may have been from 1,600 to 1,700 years old.

It is thus that the germs of vegetable life are preserved. The Winter-life of Plants! It is one of slumber and inactivity, comparatively speaking, yet how deeply interesting its preservation. What, though the trees have on at present only their plain unattractive garb of winter leaves, yet their more ornamental summer-leaf dress has been carefully prepared for them, and now lies folded up in the bud,—the wardrobe of Nature! They will put it on uninjured at the appointed time! What matters it that the fierce north winds sweep the landscape of all its visible life and fertility, and extend still farther and farther the snowy territories of winter? The flowers are all safely sheltered in their winter home,

beneath that snow covering, either in seeds or underground buds, and they will come up again in their old haunts, delicate, beautiful, uninjured as ever! Who thus protects folded leaves and sleeping flowerets?

Even in winter, Nature with unwearied hand is ever preparing food for her plant-children, when they shall awaken from their slumbers. Frost and snow are of great service: the former breaks the hard masses, and renders the soil loose and porous; the latter spreads a warm covering over the landscape, thus protecting the numerous seeds of annuals and the underground stems of the perennials. Snow contains ammonia and other nutritive gases, and when it melts, the plants drink in its nourishing constituents. Thus when winter covers the earth with snow-storms, Nature is really benevolent, although apparently stern and unpitying.

EXPLANATION OF PLATE IX.

Fig. 1. One year's growth of beech-tree (*Fagus sylvatica*).

a. Annular or ring-like scars, left on the bark by the winter leaves or bud-scales.

s. Cicatrix, or leaf-scar, left on the bark by the summer leaves.

Fig. 2. Two shoots of the horse-chestnut tree (*Æsculus hippocastanum*) placed together for comparison. The left-hand shoot is the growth of a single year, the right-hand shoot is the growth of ten years.

a. Scars left by winter leaves.

s. Scars left by summer leaves.

Fig. 3. A twig of the tulip-poplar (*Liriodendron tulipifera*).

s. Cicatrix, or leaf-scar, left by the summer leaves.

b. Linear scar left by stipular leaves, a peculiar modification of the winter-leaf.

c. A closed stipular bud.

d. An open stipular bud, with the two stipules reflected downwards, to show—

l. The lamina or blade of the embryo summer leaf inverted on its petiole, or its position whilst inclosed or packed away within the stipular leaves.

THE VINEGAR EEL

(*Anguillula Aceti*).

BY JABEZ HOGG, F.L.S., ETC.

AS much doubt seems to prevail concerning the development of the Anguillula, it appears to me a short history of these curious members of the animal creation will not be out of place in the pages of this Journal.

It was at one time believed that vinegar eels were produced "in vinegar only (as stated in foot-note, at page 501, POPULAR SCIENCE REVIEW, July), without the addition of any kind of vegetable matter;" but modern means of research have greatly contributed to our knowledge of these as well as many other minute creatures. The microscope, assisted by chemistry, has exploded the old idea and demonstrated to our senses that scarcely a liquid or a solid is free from the attacks of one or other of the many varieties of fungi, the sporules of which, ever floating about in the air, are everywhere present, and ready, in some marvellous way, to initiate the work of either reconstruction or destruction, as the case may be.

A vast number of these fungoid growths are developed in fluids during the various processes of fermentation; if, indeed, it may not be said of them, that they are the principal active agent in these apparently spontaneous reactions; all having a hidden period of incubation in these fluids, during which unseen stage they are causing the chemical changes in them, until finally a cryptogamic plant appears, multiplied a thousandfold, with each of its millions of sporules endowed with the original capacity of producing the same changes in the next fluid into which it may chance to enter.

We observe, also, another peculiarity in these low forms of vegetable life,—the remarkable facility they possess of assuming other forms and characters, which would appear to depend upon the nature and constitution of the fluid, soil, and habitat in which they were found. This fact led me to *the probable conclusion*, in my late paper on the Truffle, when noticing the ciliated motion before Anguillulæ made their appearance in the sour mass. I am now anxious that it should be known, that, upon making further examinations, I have not been able to

verify the presence of cilia upon the ova; so that I believe the action observed must have been due to the presence of some other minute animal or vegetable life; as vibriones, &c.

If we now turn our attention particularly to the development of the Anguillulæ, we shall find they constitute a very widely distributed family, belonging to a still larger order of the animal creation,—the Nematoidea, which abound almost everywhere. The whole genus were formerly classed with Infusoria, and arranged under variously distinctive names, mostly determined either by the substance or situation in which they were first discovered. The earliest contribution to the natural history of Anguillulæ appears in the writings of Turbervil Needham, under the heading of "Microscopical Observations on the Worms discovered in Smutty Corn," published in the year 1744, in a paper contributed to the Philosophical Transactions of the same period. He very correctly describes these *worms*, as he called them, and their economy, illustrating one memoir by tolerably correct figures. Yet, in a subsequent paper, he most unaccountably retracts everything he before had written respecting them, and declares "the white fibrous creatures in the interior of the corn to be true zoophytes."

Maurice Roffredi, in his memoir "*Sur l'Origine des petits Vers ou Anguilles du Bled rachitiques*," which appeared in vol. v. of the *Journal de Physique*, 1775, fully describes the Anguillulæ. He seems to have attentively observed their whole economy and many other peculiarities in the various stages of existence, although he fell into some errors with regard to their early development in the corn. He also was the first to communicate, or "enoculated," as he terms it, the disease to rye and barley, by transferring young eels to both these grains, and in which they became as quickly developed as in wheat grains.

F. Fontana also published some remarks on these minute creatures in 1776; but he fell into many errors concerning them: first, he maintained that the infected grains in which the eels are found— .

> Are extraneous tumours, or gall-nuts — the mere produce of the worms; and, secondly, that the suspension of life, or muscular action, is neither a state of torpor nor suspension, but real death or extinction of life; and that they are brought to life again as often as they are moistened with water.

But the clearest and most trustworthy account of the Anguillulæ appears in the Philosophical Transactions of 1822, by a Fellow of the Royal Society, Francis Bauer, in a memoir "On the Muscular Motion of the *Vibrio Tritici*;" and the point which struck this observer most,—indeed first led him to study them,

was their remarkable power of life. He commences by telling us, what now is well known, that—

This minute animal is the immediate cause of that destructive disease in wheat known by farmers under the name of ear-cockle or purples. On opening some of the diseased grains, I found there the whole converted into a mass of white fibrous substances, apparently cemented together by a glutinous substance, and formed into balls, which could easily be extracted entire from the grains; and which, when immersed in water, instantly dissolved, and displayed in the field of the microscope, hundreds of perfectly-organized minute worms, all of which, in less than a quarter of an hour, were in lively motion.

Having left some of them on a glass for some four or five days, they were dried up and apparently dead; but upon again moistening them with water, much to his surprise, in a very short time they began to show signs of life, and in the course of an hour were as lively as before. This experiment he made again and again, with the same results; but found that those which had been kept the shortest time under water recovered their motions soonest; so that, after a second or third suspension, at intervals of a week or ten days, they could not be revived.

If, however (he says), the second experiment be not made too soon after the first, the chances of recovering are greater. The longest interval, after a second suspension of life, I was able to recover them, was eight months. If, when first revived, they are kept in water, excluded from the air, and evaporation prevented, they remain alive and propagate for many months.

Their eggs have an extremely delicate transparent shell or structureless membrane, through which the young can be attentively observed. With some care it may be seen moving within its envelope, and, by a spinal motion, at last breaks through and escapes. The egg measures about the $\frac{1}{300}$th of an inch in length; and soon after the young animal quits the shell, it shrivels up and disappears.

Each single grain of corn contains many eels. Bauer found in one—

Seven full-grown and a hundred young eels, all alive, beside a great many eggs; and, upon being placed in water, they were seen twisting and wriggling about, like so many serpents.

He experimented upon grains, after keeping them for five years and eight months, and always with the success narrated; but he found the corn required to remain under water a much longer time before the eels were resuscitated. When they die, they remain in water, unaltered in form and character, for many days or weeks.

He supposes the glutinous substance which surrounds the eels, when he cut open the corn,

> Must be secreted by them; since, in the infected grains, the cellular tissue has entirely disappeared. From this fact, we may consider that the glutinous substance preserves the young animals from further change; and what is recorded of the snail, which can, by its own mucus, hermetically seal itself for thirty years in its shell against a wall, is similar to this.

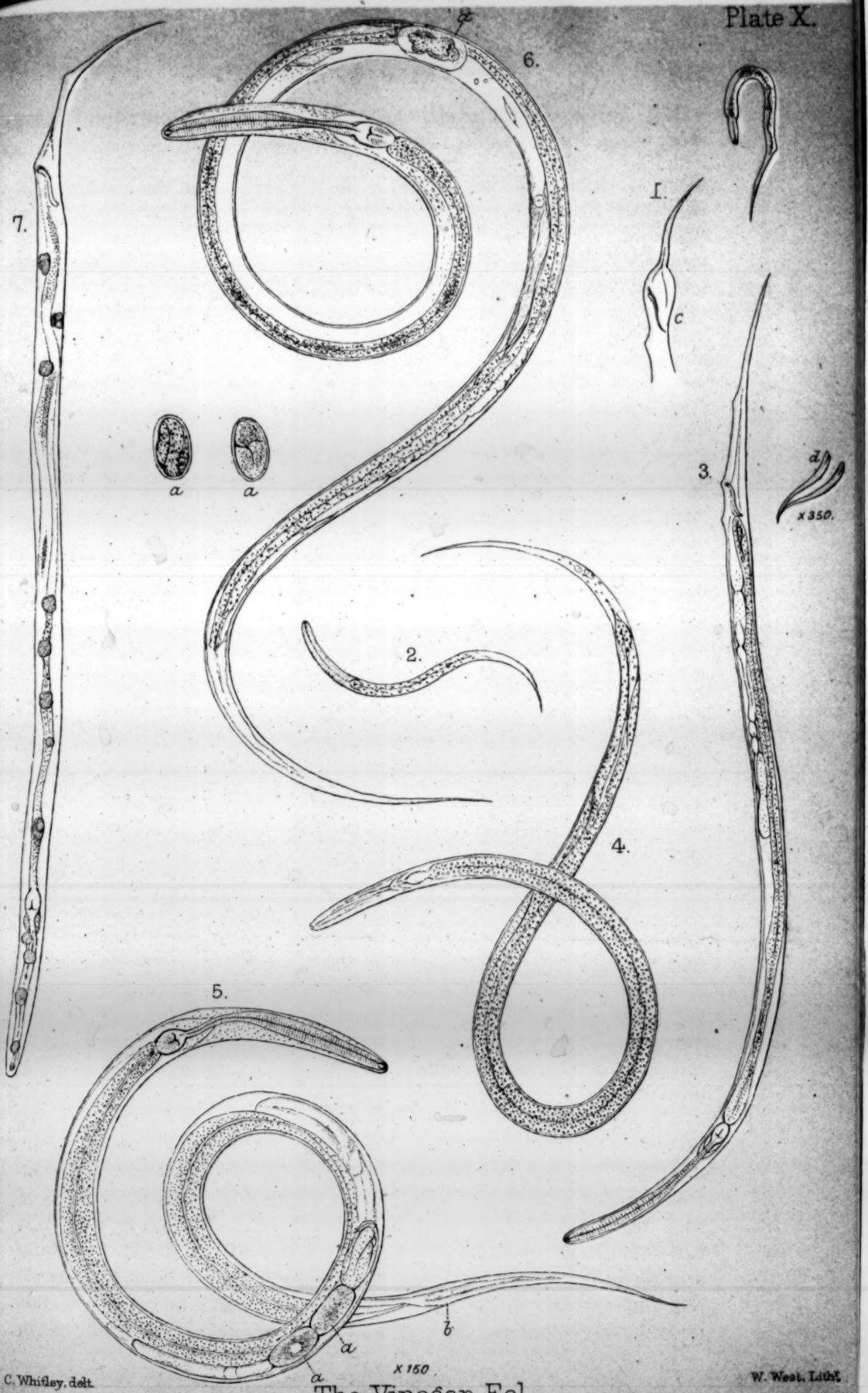
I have resuscitated them after the infected corn has been allowed to lie excluded from light and air for upwards of eight years. Indeed the whole of the species are most remarkable for their great tenacity of life, resembling in this particular the Tardigrada and Rotatoria.

The various species of the Anguillula most familiar to microscopists are—1st, *Ang. Tritici* of blighted corn,—wheat, &c.; 2nd, *Ang. Aceti*, of vinegar, or in any substances undergoing acetous fermentation; 3rd, *Ang. Glutini*, of sour paste, so precisely similar to *A. Aceti*, although authors still persist in describing it as distinct, is nevertheless exactly the same in every particular; and 4th, *Ang. fluviatilis*, found in waste waters among the decaying vegetable matters, as well as in wet moss, boggy districts, and moist earth.

It will be observed that wherever the Anguillulæ have been found, they are invariably developed in, and probably live upon, the decaying vegetable substances. The ova of these creatures are so minute, that when the earth or vegetable matter is dried up and converted into fine dust or powder, the wind takes it up, and it is driven about hither and thither over the face of the earth. The microscope has failed, as yet, to demonstrate the presence of ova mixed up with earthy or vegetable matter, before it becomes infused into the liquid material, which swells out the mass, and calls it into new life and vigour. Yet that the ova must be present, no reasonable mind can doubt, as we soon discover some chemical change going on, and suddenly the whole is converted into colonies of living eels; and such is the tenacity with which they cling to life, that no amount of exposure to either heat or cold, or other climatic influence, is able to entirely extinguish it.

Thus, it appears, from the observation of trustworthy observers, that *Ang. fluviatiles* have been exposed to the scorching heat of a summer's sun, until perfectly converted into the finest powder or dust; nevertheless the first gentle shower of rain descending upon some of this at once begins to swell it up, softens it, and, finally, creatures sporting in the sunshine appear in all stages of growth, taking food, and exercising all the various functions of the higher-organized animals. What is still more extraordinary is, that some of them delight in

Plate X.



C. Whitley, delt.

W. West, Lith.

The Vinegar Eel

strongly acid or corrosive liquids, such as would be poisonous to most other creatures. It may in reality be said of them that they live only in substances unfavourable to life in most other animals.

The *Anguillula Aceti* is only found in the inferior and diluted vinegars of commerce. In the strongest vinegars sent out by manufacturers of repute, it never occurs; the reason of which is, that considerable care is taken to separate all mucilaginous or albuminous vegetable matters from the acid. This is effected by certain refining processes, as well as by the addition, allowed by law, of a certain quantity of oil of vitriol (sulphuric acid) to every gallon of vinegar, before it is sent out to the retailer. The legal quantity of this strongly corrosive acid is often exceeded in the commoner or badly manufactured vinegars; otherwise they would rapidly spoil, and generate the vinegar eel, and become mouldy, or mothery, as it is more commonly termed.

Dr. Hassall found that many other ingredients are used in the adulteration of vinegar; and in eighteen samples out of twenty-eight examined by him, he found not only a larger proportion of the oil of vitriol than there should have been, but also remains of vegetable and other matters, some of which were positively of a deleterious nature. Nevertheless, in a very short time, all were soon more or less covered over by some fungoid growth. From this fact we may gather that very great difficulty is experienced in preventing the vinegars of commerce from undergoing rapid decomposition; doubtless arising from the facility with which the sporules of fungi, as well as other organized bodies floating about, find a ready access to the fluid, and which appears to afford all the required elements for development and growth.

Although well known that water is rarely if ever found free from the presence of either living or decaying vegetable matter, we were, perhaps, not quite prepared to find another fluid, having a large admixture of a strongly corrosive acid, and which at first sight might, without much hesitation, be pronounced noxious to the growth of either vegetable or animal, offering a suitable nidus for the development and nourishment of both; and we at once see that it would be quite at variance with facts to say that vinegar eels "are developed in vinegar *only*, without the addition of any decaying organic substance."*

* The foot-note twice referred to in the course of this paper is our own: and our readers might be disposed to infer that there is a difference of opinion between the author and ourselves. This is not the case. When we spoke of "vinegar only," we referred to the addition of slices of truffle, and

The accurate drawing of the vinegar eels made by Mr. C. Whitley for this paper, so faithfully portrays the little creature in its several phases of life, that it appears unnecessary to add anything by way of further description. It may, however, not be uninteresting to add, that this minute and curious eel is not unfrequently made the means of practising upon the unwary a gross but very characteristic imposition by the advertising quacks who infest this great metropolis. A victim offering himself to be fleeced is usually received in a well made-up room, lined by book-cases and illuminated diagrams of the organic structures in the human body, healthy and unhealthy. Instead of the old-fashioned stuffed alligators suspended from the ceiling, the Paracelsus of modern times ostentatiously parades the most showy and expensive microscope obtainable, in closest consultation with which he takes care to be found by the patient, just as an *ant-lion* may be supposed to be studying nature as he reposes at the bottom of his conical trap, the sloping sides of which, made up of the finest sand, prove a very *facilis descensus* to his unsuspecting prey, who ventures on the treacherous surface. Proceeding to business after some preliminary anxious inquiries, *the doctor* (!) gravely proposes to aid his diagnosis by that crucial test, the microscope. The dismay of the poor victim may be more easily imagined than described, when, on being pressed to see for himself, the state of affairs is revealed to his agitated mind, in a mass of wriggling little worms, disporting themselves in the smallest drop of fluid derived from his natural juices. The doom of Herod—"and he was eaten of worms"—to him needs no more elucidating commentary, and if the conscience-smitten patient does not, like the tetrarch, presently give up the ghost, he is in a very apt mood to part with all the cash he may have about him, in order to be kept out of a situation, the horrible nature of which, had it not thus been demonstrated to his senses, he could never have conceived. I have sketched no overdrawn picture, but rather one, I fear, of daily occurrence; and the manner all this is effected is exceedingly simple. The smallest particle of *sour paste*, previously placed on a slip of glass, lies imperceptible to the unpractised

never meant to infer that the vinegar itself contains no organic matter. But there is no need to discuss the question of heterogenesis with reference to vinegar; for *boiled distilled water alone* will, if exposed for a few days (under certain conditions of the atmosphere), be found to contain distinct types of *Infusoria*. This fact we discovered last summer, and communicated to Section D of the British Association. So our scientific readers must not suppose that we have been seeking to adduce evidence in favour of the theory of spontaneous generation.—ED.

eye, until a single drop of any fluid secretion from the body supplies the required conditions of moisture; and, accordingly, the little paste-eels are immediately aroused to life and activity, reversing the fable of the frogs and boys, as the lively enjoyment they exhibit is apt to prove a very serious matter to the human being so shamefully victimized.

EXPLANATION OF PLATE X.

Figs. 1 & 2. Young animals soon after leaving the egg.

Fig. 3. Male, full grown.

Fig. 4. Male, with reproductive organs *in situ*, separated at *c* and *d*, and magnified × 350.

Figs. 5 & 6. Females, with ovisacs *in situ*, containing eggs in various stages of development.

a a. Eggs thrown off and found floating in the fluid.

Fig. 7. A dead male, in which state they float about for days, until destroyed by vibriones.

THE EYE OF THE OX.

BY E. BECKIT TRUMAN.

HOMER, the sublimest, because the most natural, of the classic poets, expresses his idea of the majesty and beauty of the countenance of Juno, by the epithet *boōpis*, ox-eyed. The simile may, perhaps; appear a very humble one; but, by a little study of the formation of the bullock's eye, we may see that not only is the object worthy of the Homeric application, but that it contains numberless beauties of which the ancient Grecian never dreamed, disclosed to us by the aid of the dissecting-knife and the microscope.

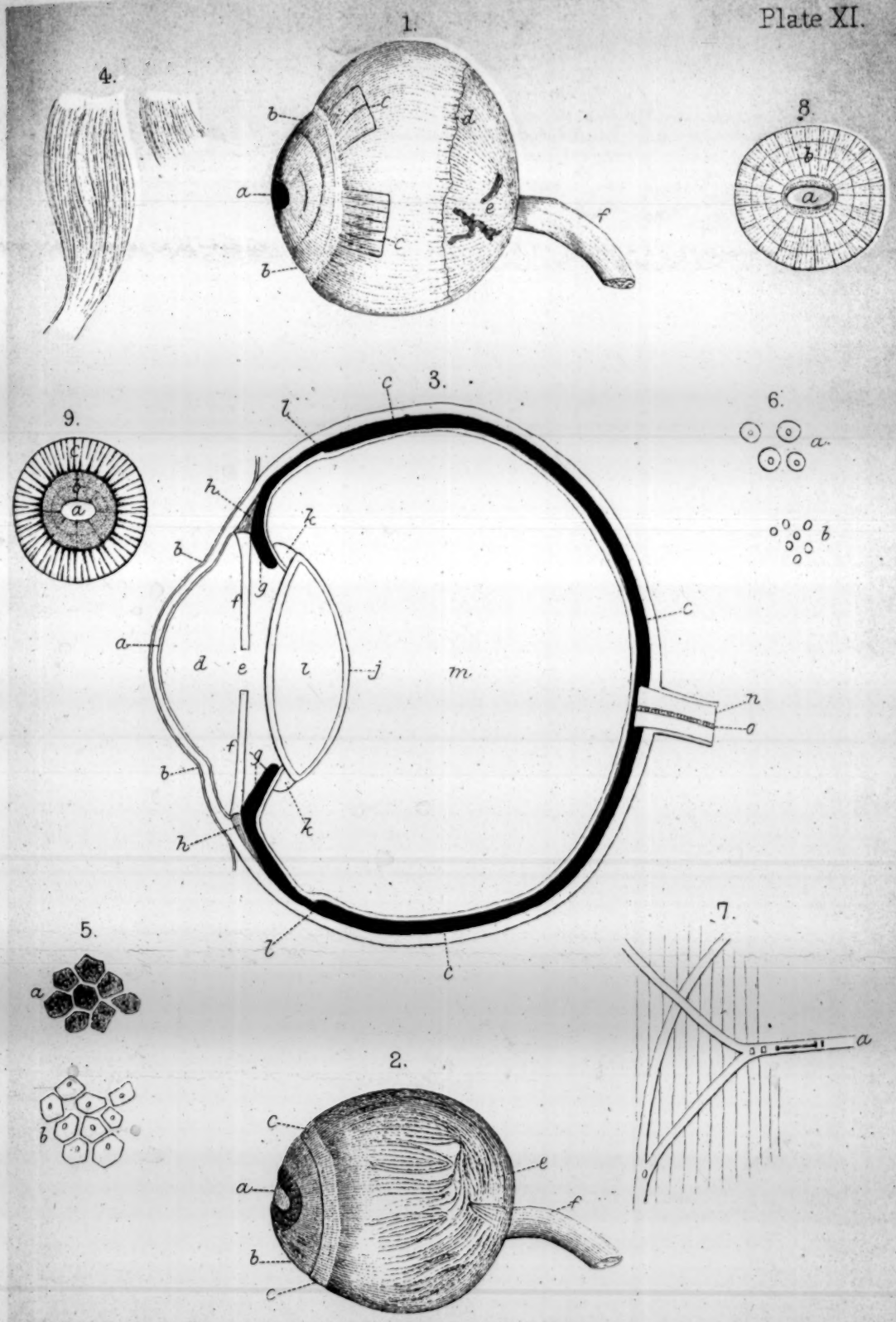
The delicacy of the internal organization of the eye requires it to have an abode where it will be protected from external violence. Such a dwelling-place we find in the orbit or socket of the eye: which is formed of bone on all sides, and lined by a cushion of fat, in which the eyeball is embedded; so that in the event of a blow being received on the only attainable aspect, the front of the eye, its force is transmitted to, and broken by, this soft layer of fat, and thereby prevented from rebounding injuriously on the eye from the unyielding wall surrounding it.

Having removed the eyeball from its socket, and divested it of the fat and the muscles, let us examine the contour of the eye (Plate XI., fig. 1). We see it to consist of two portions, of differing curvatures, the part in front (*a*) having the greater convexity; the remaining and greater portion having the form of a somewhat-flattened globe. The projecting body (*f*) is the optic nerve, the nerve that conveys the visual impressions to the brain; at *c* and *d* are the attachments of muscles cut short; and at *e* some blood-vessels are seen.

We will now examine, one by one, the different structures of which the eyeball is composed; and which consist (1) of tunics or protective coverings, (2) of a series of refracting bodies to bring the rays of light to a focus internally, and (3) a nerve to receive the impression of light (with certain auxiliaries).

The outermost covering of the eye consists of two very dissimilar parts; namely, the cornea and the sclerotic. The cornea,

Plate XI.



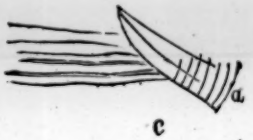
E. B. Truman, delt. ad nat.

W. West, Lith.

The Eye of the Ox,
and its microscopical Structure.

so named from its similarity to horn (*corneus*, horny), is compared in shape to a watch-glass; it is perfectly transparent (in Plate XI., figs. 1 and 3, extending from *b* to *b*). Although perfectly transparent, even as glass (that is, to the naked eye), it has a fibrous structure (fig. 10), the fibres being very even and regular, and running parallel to each other; between the fibres are a number of tubes, pursuing also a regular, parallel course. In front of the cornea is a thin elastic layer, covered by a transparent cuticle; and behind the cornea is another elastic layer, which passes on and terminates in the iris. These elastic membranes preserve the proper convexity of the cornea (in fig. 3 the situation of these laminæ may be seen; in fig. 11, their structure is shown).

Fig. 10.



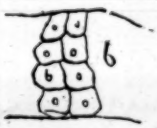


Fig. 11.

The sclerotic (*sklēros*, hard) is an exceedingly strong structure directly continuous with the cornea, and investing the eyeball completely, except where the cornea comes in (extending from *b* round by *c*, *c*, *c*, to *b* again, in Plate XI., fig. 3). It is about $\frac{1}{16}$ of an inch in thickness, and its fibres (Plate XI., fig. 4) are not, as those of the cornea, parallel, but run in contrary directions, mostly crossing each other at right angles; hence the dense and strong nature of this covering. What is popularly known as the white of the eye, is a part of the sclerotic, covered by a thin mucous membrane. To the sclerotic are attached the various muscles that move the eyeball, and behind, it is perforated for the passage of the optic nerve (Plate XI., fig. 3, *n*).

Looking at Plate XI., fig. 3, it will be observed that at *h* is a part coloured yellow: this consists of two structures, one behind the other; the first is called the ciliary ligament, the second, the ciliary muscle. By means of the ciliary ligament (a ligament being something that binds and connects parts together: *ligo*, to tie or bind), the iris (Plate XI., fig. 3, *f*, *f*) is attached to, and suspended from, the sclerotic. On removing the cornea and sclerotic, during which we must separate the latter from the ciliary ligament, we obtain a body similar to Plate XI., fig. 2. We notice that the eye has lost its high-arched form: this is due to the fact that the semi-fluid material forming the bulk of the eye has now but very weak structures surrounding it, and therefore tends to flatten downwards.

The choroid coat of the eye (like the chorion, which is a vascular membrane of peculiar formation, *chorion*, *eidos*), is that next beneath the sclerotic; it extends from the entrance

of the optic nerve, which perforates it, to the ciliary ligament (Plate XI., fig. 2, *c, e, c*), where it forms the iris and ciliary processes. The choroid consists almost entirely of blood-vessels, and colouring matter, or pigment, contained in irregularly-shaped cells in the interval between the blood-vessels. By washing gently with water, the pigment on the surface may be removed, and we then see the veins running in great numbers, and in a beautifully-arranged manner, from behind forwards. The irregularly parallel lines seen in Plate XI., fig. 2, are the veins. The innermost layer of the choroid consists of a series of little bodies, called epithelial cells, arranged in the manner of a pavement; in the eye of man, and in the front of the eye of the ox, these are full of dark colouring matter (Plate XI., fig. 5, *a*). The back of the eye of the ox, however, instead of presenting a dull black appearance (as in man), is of a mingled blue and green colour, and very brilliant, having quite a metallic lustre. This is due to the presence of certain fibrous elements in the choroid, so arranged as to give the play of colours named: for there is, on examination, no colouring matter to be seen; the epithelial cells of this part having the microscopical appearance of *b*, Plate XI., fig. 5. This bright and coloured surface is of considerable extent, and is called the tapetum (*tapēte*, a carpet).

At *c*, Plate XI., fig. 2, is the ciliary ligament and muscle. At this point the choroid bends inwards to form the ciliary processes and iris. The ciliary processes (*cilium*, an eyelid or eyelash), (Plate XI., fig. 3, *g, g*, and the outer circle in Plate XI., fig. 9, where they are seen from behind), consist microscopically of the same structures as the choroid; they are formed by the choroid bending inwards and backwards from the ciliary ligament towards the lens (Plate XI., fig. 3, *i*); together they constitute a circular band, with a large central aperture at its circumference continuous with the choroid, and also attached to the iris, but free at its margin and front surface. These processes consist of folds or plaits which are arranged around the lens, "like the many petals of a flower;" the folds are both long and short: the long ones, about sixty in number, running concentrically along the entire breadth of the processes; the short ones are placed alternately with the long ones, commencing at the circumference, but terminating about halfway from the margin of the large central aperture.

The consideration of the iris and ciliary muscle we will reserve for the present, and will examine the layer immediately beneath the choroid, namely, the retina (*rete*, a net) (fig. 3, the scarlet line running around the globe). This is the nervous structure which receives the impression of light,

and is formed by an expansion of the optic nerve (Plate XI., fig. 3, *n*), commencing at the entrance of the optic nerve into the eyeball, and extending as far as *l*, where it terminates by a finely-jagged border. The retina is an exceedingly delicate structure, and is admirably supported, as if on a water-bed, by a globular mass of almost fluid consistence. It is itself semi-transparent, and of a greyish-white colour; and is traversed by many branches of a blood-vessel (whence its derivation from *rete*), which is seen at *o*, in Plate XI., fig. 3, passing through the midst of the optic nerve to supply the retina with blood. The retina consists of two layers: Jacob's membrane, and the retina proper; Jacob's membrane (so named, because first described by Dr. Jacob) is the outer one of the two, and is seen as a thin film, by a careful dissection made in water: it is formed of a number of rod or club-shaped particles, lying side by side, and with the long axis vertical, the broad end of the particles being in contact with the choroid; the other end, of course, in opposition with the retina proper. The appearance of the membrane seen from without is represented in fig. 12, *b;* that of its vertical section in fig. 13, *a;* and that of the particles when detached at fig. 12, *a*.

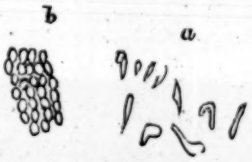


FIG. 12.

The retina proper may be described, in a general way, as made up of three parts: a fibrous, a vesicular, and a granular layer (fig. 13, *b*, *c*, *d*). The fibrous layer, *d*, is derived from the optic nerve; the fibres of which radiate from the end of the nerve, where it perforates the sclerotic and choroid, and forms a thin sheet of membrane: the vesicular layer, *c*, is composed of a number of delicate bodies called vesicles (*vesicula*, a little bladder or blister), seen separately in Plate XI., fig. 6, *a*. In the fibrous and vesicular layers the blood-vessels of the retina are distributed. The granular layer, *b*, is that which lies immediately beneath Jacob's membrane, *a*, and consists of particles, such as those in Plate XI., fig. 6, *b*.

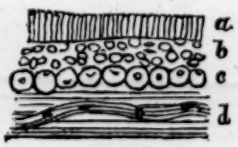


FIG. 13.

I have said that the retina is supported and kept extended on a semi-fluid material; this is called the vitreous humour (*vitrum*, glass), and occupies the whole of the space marked *m* in Plate XI., fig. 3. It is of the consistence of soft jelly, and is formed of an exceedingly fine and delicate web of fibrous tissue, which is at the same time transparent, and which contains within its meshes a watery fluid. It is bounded, at its circumference, where it comes in contact with the retina, by a thin and transparent membrane (the line next to the scarlet

retina, Plate XI., fig. 3), called the hyaloid membrane (*hyalos*, crystal); when this membrane reaches the ciliary processes of the choroid (at *h*, fig. 3), it forms a number of plaits, similar in number, disposition, and size to those of the ciliary processes, and which are received into the folds of those processes. This plaited part of the hyaloid is called the *zonula ciliaris* (*zonula*, a little girdle). If, in Plate XI., fig. 3, we trace the hyaloid membrane to its termination, we see that it ends on the front surface of the lens, *i*, and immediately behind it, at this point, is a space, *k*, called the canal of Petit: this little cavity has an important function, and is bounded behind by the vitreous body, in front by the hyaloid membrane, and internally by the lens.

The crystalline lens (Plate XI., fig. 3, *i*, and fig. 14) is when seen from the front circular, when from the side doubly convex, in form; the posterior curve being the more convex of the two. The lens is surrounded by a membrane or capsule, that invests it completely; the capsule is of the same structure as the elastic lamina of the cornea. The front part of the capsule is three or four times thicker than the part behind; which latter part is adherent to the tissue of the vitreous body, and therefore is better supported than the capsule in front, which is in contact with a thin fluid, presently to be noticed.

The lens itself is of considerable consistence, such as the white of an egg when gently boiled; its density in the centre being greater than that of the outer part. Looking at it in front, we see, when the lens is beginning to lose its transparency, three lines, which commence at the centre and radiate outwards, dividing the lens into three equal parts; the same is observable on the posterior surface, but the lines behind are placed intermediately with respect to those in front. By hardening it in spirit we may separate the surfaces of the lens into three parts, and we then see that it is composed of layers or lamellæ (fig. 15); and these again consist of fibres, which, in the ox, have finely-jagged edges (fig. 16).* Notwithstanding all this complicated structure, the lens is perfectly transparent.

Fig. 14.

Fig. 15.

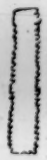


Fig. 16.

The parts remaining to be noticed are the anterior and posterior chambers of the aqueous humour, the iris and the ciliary muscles.

The anterior chamber (*d*, Plate XI., fig. 3) is bounded, in

* From Todd & Bowman.

front, by the posterior surface of the cornea, and a small portion of the sclerotic; behind, by the front of the iris; *e* being the pupil of the eye through which the two chambers communicate. The posterior chamber is formed by the posterior surface of the iris, by the front of the ciliary processes, and lens, and a small part of the hyaloid membrane. These chambers contain a fluid nearly as thin as water; and therefore called aqueous humour (*aqua*, water).

The iris (Plate XI., fig. 2, *b*, 3, *f*, 8, 9, *b*,) is a circular diaphragm, with a central aperture called the pupil (fig. 3, *e*, 8, 9, *a*); it is attached, at its circumference, by means of the ciliary ligament (which is seen with the ciliary muscle at *c*, *c*, Plate XI., fig. 2) to the sclerotic. The iris consists of muscular fibre, of blood-vessels, and of colouring matter. The direction of the muscular fibres is mostly radiating; but at the inner margin of the iris are a few fibres which have a circular arrangement around the pupil. The vessels are numerous, but slender and delicate. The colouring matter is situated in irregularly-shaped cells, which very much obscure the microscopic structure of the iris. When we speak of a blue eye or a hazel eye, we always refer to the colour of the iris; which is so named from its varying colours in different individuals (*iris*, a rainbow). The pupil is so named from *pupilla*, a young girl or child, as in the situation of the pupil, a diminutive image of the person looking at it is formed by reflection from the crystalline lens: amongst the Greeks, in the same way, the pupil was called *korē*, the daughter of the eye.

The ciliary muscle (Plate XI., fig. 2, *c*, 3, *h*) is a circular band, attached on one side to the sclerotic, and by the other to the front of the ciliary processes. Its fibres radiate from the attachment to the sclerotic, some to the posterior part of the ciliary processes, some to the more prominent parts, where the processes approach the lens.

We will now consider the functions of the different parts of the eye during the passage of the light rays. We see an object, because rays of light are reflected from the surface of the object, and meet the eye, the impression subsequently passing to the brain. These reflected rays diverge from each other, more or less, according as the object seen is at a less or greater distance from the eye. At a distance of eighteen

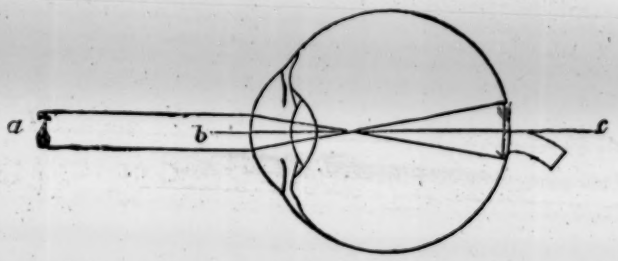


FIG. 17.

feet, however, the rays of light are already so little divergent, that they are accounted parallel; whilst at a less distance than eighteen feet the rays are called divergent. The course of parallel rays is as follows (fig. 17): reflected from *a*, the rays pass to and through the cornea, where they are bent or reflected towards the axis of the eye (*b*, *c*); they then pass through the aqueous humour to the crystalline lens, where they are still more refracted, so as to cross the axis of the eye, and, traversing the vitreous body, terminate on the retina, where an inverted image of the object is formed.

If any divergent rays from a near object were to pass through the eye, whilst the eye was in the same state as that in which the parallel or distant rays come to a focus, the effect would be that the picture of the object would form behind the retina, and thus perfect and well-defined sight would be impossible for near objects. To meet this there is a little mechanical arrangement in the interior of the eye. The ciliary muscle (Plate XI., fig. 3, *h*), attached in front to the sclerotic, and behind to the ciliary processes, when in action (that is, when the eye is adjusted for near objects), pulls forward the ciliary processes, and therefore the plaitings of the hyaloid membrane; and by means of the attachment of the hyaloid to the circumference of the lens, this body is also brought forward; the canal of Petit prevents the muscle acting on the vitreous body, by leaving a space between. By this means a greater distance is produced between the lens and the retina, and thus the image of the object is brought to a focus directly upon the retina.

There is nothing that man can construct to equal, in beauty of mechanism, the iris. It is a curtain, circular in shape, and with an aperture in the middle, which can either contract or dilate without showing the least puckering or plaiting of the surface of the iris. The contraction of the pupil takes place in a strong light, and is intended to exclude an excess that would act injuriously on the retina; the dilatation takes place in dull light or darkness, for the purpose of allowing every possible ray to pass.

During adjustment of the eye for a near object, it is turned inwards, and the same nerve by which this movement is effected causes contraction of the pupil. This contraction probably merely excludes excess of light, and does not aid adjustment of the eye; as adjustment has been observed to be perfect even when the iris was entirely absent.*

* For much interesting and valuable information respecting the eye, see the second volume of Todd & Bowman's "Physiological Anatomy;" Griffiths & Henfrey's "Micrographical Dictionary" (Van Voorst), article "Eye"), and the books of reference there named.

EXPLANATION OF PLATE XI. AND WOODCUTS.

Fig. 1. The eye of the ox, seen laterally, the muscles having been removed. *a*, the pupil of the eye; *b* to *b*, the cornea; *c*, *c*, and *d*, ends of muscles; *e*, blood-vessels entering the eye: *c*, *d*, and *e*, are on the sclerotic; *f*, the optic nerve.

Fig. 2. The same; the cornea and sclerotic have been removed. *a*, the crystalline lens, seen through the pupil; the band, *c* to *c*, is the ciliary ligament and muscle; *b*, the iris; *e*, the choroid, showing its vessels; *f*, the optic nerve.

Fig. 3. A diagrammatic section of the eye, enlarged. *a*, the cornea, consisting of anterior elastic lamina, cornea proper, and posterior elastic lamina; *b* to *b*, by *a*, shows extent of cornea; *c*, *c*, *c*, the sclerotic; *d*, the anterior chamber of the eye; *e*, the pupil; *f*, *f*, the iris; *g*, *g*, the ciliary processes; *h*, *h*, ciliary ligament and muscle; *i*, the crystalline lens, surrounded by its capsule, *j*; *k*, *k*, the canal of Petit; *l* shows the termination of the retina (the scarlet line); the black line between the retina and the sclerotic is the choroid; the light line beyond the retina is the hyaloid membrane, which passes on to the lens; *m*, the vitreous body; *n*, the optic nerve; *o*, the central artery of the retina.

Fig. 4. Fibres of the sclerotica.

Fig. 5. Epithelium of the choroid. *a*, from the dark part in front; *b*, over the tapetum.

Fig. 6. *a*, detached vesicles; *b*, detached granules, from the retina.

Fig. 7. Fibrous layer of retina; *a*, a blood-vessel.

Fig. 8. The iris, seen in front; *a*, the pupil; *b*, the iris.

Fig. 9. The iris and ciliary processes, seen from behind; *a*, the pupil; *b*, the iris, partly hidden by *c*, the ciliary processes.

Fig. 10. Transverse section of the cornea proper.

Fig. 11. Section of anterior elastic lamina. *a*, cornea proper; *b*, epithelium; *c*, elastic lamina.

Fig. 12. Jacob's membrane. *b*, when seen from above; *a*, appearance of detached particles.

Fig. 13. Section of retina. *a*, Jacob's membrane; *b*, granular; *c*, vesicular; *d*, fibrous layer: along the latter is seen passing a blood-vessel.

Fig. 14. The crystalline lens, seen in front.

Fig. 15. The lens, separating into three divisions, and showing its laminated structure.

Fig. 16. Fibre of the crystalline lens (Todd and Bowman).

Fig. 17. Diagram to show the inverted image produced on the retina; *b*, *c*, the optic axis.

Figs. 4, 5, 6, 7, 10, 11, 12, and 13 are reduced from the microscopic appearances at 250 diameters, drawn by the camera lucida.

MARS.

BY JAMES BREEN, F.R.A.S.

OF all the planets of the system, MARS, which for the last few months has been shining so brightly in the heavens, is that whose topographical details are best known to us. By glancing over the accompanying pictures of its telescopic aspect, we immediately perceive how much is revealed of its surface,—of its islands, continents, seas, and snows, by means of powerful optical aid. It is the planet which most strongly resembles the Earth in the duration of its days and seasons; the existence of an atmosphere is everywhere apparent: being proved by the dimness of the dark streaks and spots at the circumference, as compared with their distinctness at the centre of the planet (for at the former the solar light has to penetrate through a dense stratum of air, and is again refracted through the same thick medium);—by occasional clouds passing over its surface;—by the snow-zones piled up and stretching over vast spaces at its poles in the winter, which melt away gradually as the Sun ascends above the horizon in the summer, and dissipates the frost and darkness which for months previously had reigned in those arctic and antarctic regions. In the planet Jupiter a small telescope may more readily show the dark belts and spots; but those are ever changing and drifting about with variable velocity; the *terra firma* is scarcely perceived on this immense body, which appears to have an economy of its own, hidden from us by great masses of cloud, through an occasional break of which we perhaps sometimes catch a glimpse of the dark body of the planet. On the surface of Mars, on the contrary, the dark spots preserve the same position and relative dimensions, and we appear to be looking at a miniature globe pencilled over with dim seas and continents. From year to year the sea does not appear to encroach upon the land, nor the land upon the ocean; all the changes which are perceived are purely meteorological—the presence of clouds and murky weather, and snow during the winter,—of a clear atmosphere and sunny clime throughout the summer.

The first circumstance we detect in looking at the planet Mars, is its exceedingly red light, which is quite different from

that of the other bodies that circulate about the Sun. This does not appear so prominently, however, when looked at with a telescope, as when seen by unaided vision. Still, however, even with the former, the orange light is very decided, and if compared with the Moon or a neighbouring white star, the contrast is sufficiently striking. Viewed when the whole disc of the planet is illuminated, its form appears quite circular, and no suspicion is aroused of a flattening at the poles, or bulging forth of the equatorial regions. But when the micrometer is applied, and careful measurements are made of its polar and equatorial diameters, several observers have agreed that there is a slight variation from the circular form, although the results which they have obtained are very discordant. Herschel was the first who suspected the elliptical form of the planet, and who patiently set about to determine the amount of this variation. To arrive at a knowledge of the figure of the Earth requires long and arduous labour; but in the case of the planets the method is more simple, and the diameters at different parts of the disc may be said to be measured with the same facility as if it were a palpable object. Herschel found that the proportions of the equatorial diameters of Mars were as 1355 to 1272, or near as 16 to 15. Schroeter could not perceive any such ellipticity, and was of opinion that the two diameters were in the proportion of 81 to 80. Arago found them to vary in the proportion of 31 to 30. The Greenwich observations of late years give this variation as 52 to 51, and as 62 to 61. Other observers, among whom is Bessel, have not been able to detect the slightest difference between the diameters. Herschel, however, states, that on one occasion he showed the planet to some scientific friends, one of whom considered that it was as considerably bulged out at the equator as the globe of Jupiter. At certain times, as the whole surface of Mars is not illuminated, it will appear of the same figure as the Moon when three or four days before or after full; but even when this was the case, the flattening at the poles was still readily perceived by Herschel. There are a few circumstances which militate against the correctness of those measures; sometimes the white cap of snow seems to project over the edge of the planet, at others the equatorial margins are exceedingly bright and radiating. According to theory, the proportion of the polar to the equatorial zone should be as 192 to 193; but different degrees of density at various parts of the globe would, of course, alter this. By observations made in September and October of 1862, Mr. Main concludes its polar diameter to be 4,221 miles, and its equatorial 4,332 miles,—a great difference for a small body like Mars, which has almost the same density as the Earth. In the latter body, the difference between the

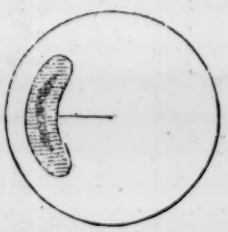
polar and equatorial diameters amounts only to twenty-six miles; these quantities being respectively 7,899 and 7,905 miles.

Be the planet circular or elliptical in figure, however, it is easy to see that it rotates on its axis, and that too in about the same time as Mercury, Venus, and the Earth. In other respects, also, the similarity is striking, these planets being nearly of the same size, globular figure and density, and differing greatly from the huge exterior planets in those respects. The rotation of Mars is readily perceived by watching it from hour to hour throughout the evening, when it will be seen that the dark spots pass over the disc from west to east in the same sense in which the Earth is rotating. In about twenty-four hours and thirty-seven minutes, or on the following evening, the spot which was first observed will be found to have returned exactly to the same position, and the others will follow in the same succession as on the previous day, the polar snow-spot retaining nearly the same place. By further watching, the patient observer will find that the equator of Mars is only inclined a few degrees more to the plane of its orbit than that of the Earth, and that, consequently, their seasons are about the same. From the longer year of Mars, however, the interval during which the polar regions are hidden from and exposed to the rays of the Sun, is very different. At the latitude of the British islands, the shortest day on Mars is only about six hours, whilst on the Earth it is between seven and eight. The longest day on Mars, at the same latitude, would be nineteen hours, whilst on the Earth it is only seventeen hours. At seventy degrees of north latitude the Sun remains above the horizon for sixty-nine days, whilst on Mars at the same latitude it is above the horizon for 169 days. The pole of Mars is exposed to the Sun for 338 days, and hidden from it for the same time; whilst on the Earth the polar day or night is only 180 days.

Some observers have complained of the striking monotony and uniformity of the surface of Mars. If we cast a glance at the accompanying pictures of the planet, we shall hardly be disposed to indorse this opinion. On the contrary, the variety of scenery is deeply interesting. The seas, or dark portions, are remarkably sinuous in their course; the indentation of the coast, caused by bays and creeks, is very picturesque. It is true that mountains and vales, such as those on the arid surface of the Moon, cannot be perceived; but by attentive watching, it will be seen that the bright portion of the planet is curiously dotted over with a mottled ground, and that the dark seas vary greatly in the intensity of their tint, even when the spot is at the centre of the planet, and is viewed most favourably. It

would appear, from a cursory view, as though the surface of Mars were pretty equally divided between land and water, the former, indeed, from Maedler's map, having somewhat the predominance, whilst on the Earth the ocean covers three times as much space as the land.

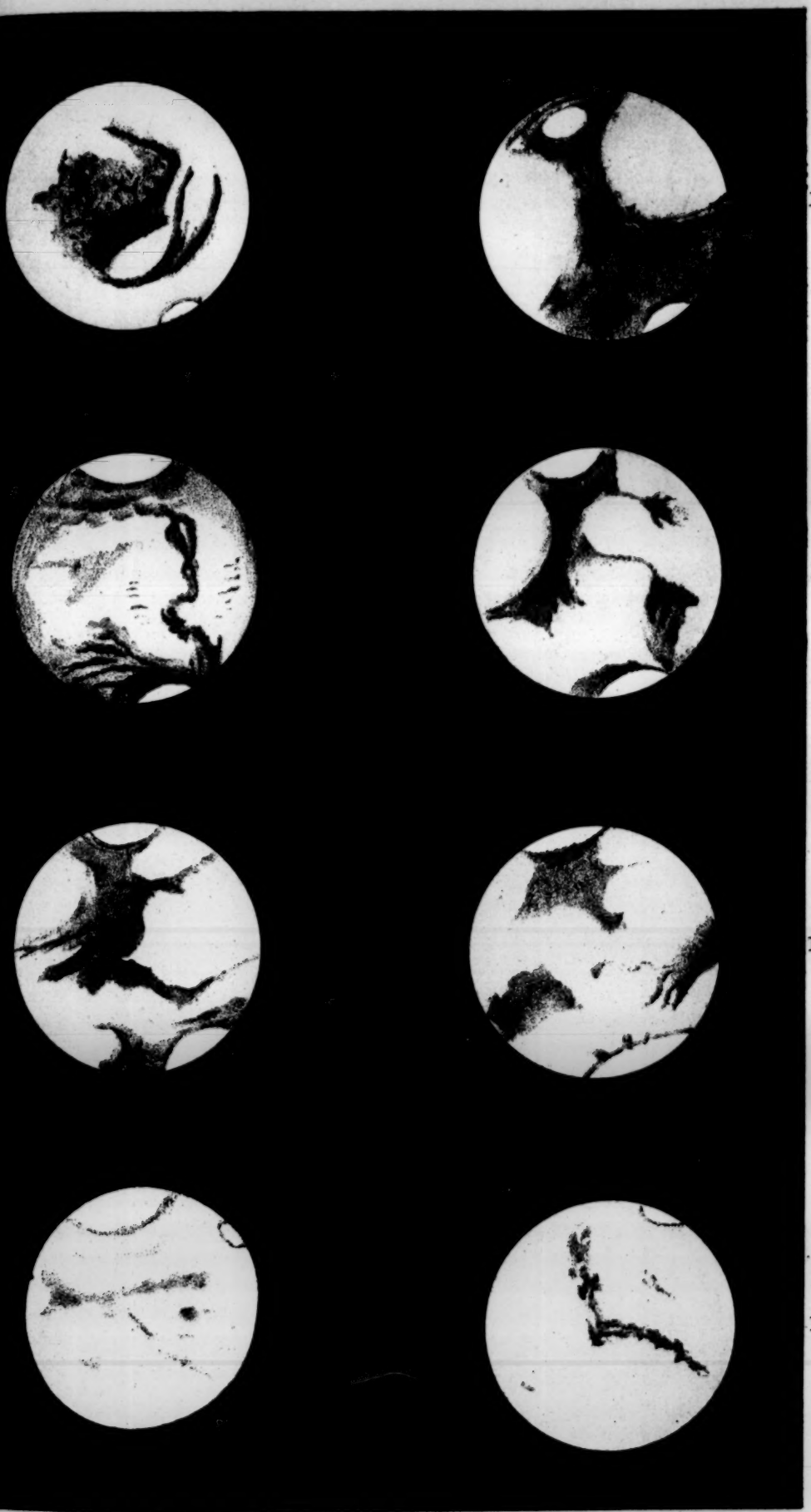
Whilst observing the spots on Mars, we are somewhat astonished to see that, as they pass from the centre towards the margins of the planet, they become rapidly fainter, and that at the edges they are entirely obliterated. Even the darkest spots on Mars (those which are seen between twenty and forty degrees of south latitude) undergo this change as they approach the margins of the planet. Occasionally the whole circumference of the planet is surrounded, as it were, with a luminous ring, as in Plate XII., fig. 1, which represents the planet as seen by the writer in the 20-foot refractor at the Cambridge Observatory, in the opposition of 1856. This is generally held to be due to its atmosphere, which is considerably thicker at the edges than at the centre, just as during a fog we can perceive the blue sky and stars over-head, which are quite invisible at the horizon, where the atmosphere is considerably deeper and thicker. We might thus conclude that Mars has an atmosphere of considerable density; and this is confirmed by other circumstances. The older observers attempted to prove the existence of a dense atmosphere in Mars, by the disappearance of stars even at considerable distances from the planet, which they imagined had been eclipsed by its extensive gaseous envelope. This has been repeatedly tested in modern times, and with the best instruments, but without success. The elder Herschel followed very faint stars close up to the margin of the planet, and Sir J. South has repeated the experiment more recently without perceiving any change in the brilliancy or colour of the very small stars selected. Whilst Cassini could not perceive a star of the fifth magnitude within six minutes of the margin of the planet (on Oct. 1, 1672), Herschel could perceive stars of the twelfth and thirteenth magnitudes within three minutes of its disc. Herschel, however, fully believed in the existence of a dense atmosphere surrounding the planet,



having often seen, besides the permanent spots on its surface, occasional changes of partial bright belts. The late Dr. Pearson

saw a similar phenomenon in 1828, having noticed a dark cloudy spot to have changed its position, in an interval of four days, from the side to the top of the planet (see diagram). One very persevering observer, however (Maedler), thinks that many very natural mistakes may occur on this point, and considers that if the spots are not narrowly scrutinized each night, one of them may readily be mistaken for a cloud. This observer has, however, noticed that the spots on Mars are of varying colours at different times; some of them are black, others yellowish-red, and others again of a greenish tint. On the Earth, however, the same change of tint would be apparent; the great forests would be dark in comparison with the bright sandy deserts; the Black, White, and Red seas might appear of different tints; yellow fogs and the "brickdusters" of Australia would cause a proportionate change in the apparent colour of the countries which they enveloped, and over which they hung. This is perhaps a more natural explanation of the colour of Mars than that which accounts for its peculiar appearance by the tints assumed by the vegetation on the planet. Without, however, having recourse to accidental fogs and clouds, it has been supposed that the dense atmosphere of the planet absorbs all the violet rays of the solar light (which has to pass twice through its atmosphere before reaching the Earth), and that only the red rays—those of the rising and setting Sun when passing through dense mist or cloud—make their way to our planet, the others being either reflected or absorbed.

Let us now turn our attention to the snowy zones about the north and south poles of the planet. By direct measurement with an instrument for estimating light, it has been found that those white spots have twice the intensity of the dun-coloured portions of the planet. In the earliest years of telescopic discovery they were duly noticed, and their appearance and disappearance, and the various changes which they underwent, were curiously scrutinized for a considerable length of time, before, however, any one surmised that the changes were caused by atmospheric variations. By his observations between 1779 and 1784, the elder Herschel placed this matter beyond all doubt. In the latter year he detected all the changes which have since been observed and confirmed in this planet; and although Maraldi had seen the changes, and prophesied the extinction of the north snow-spot as far back as 1719, yet to Herschel is due the credit of their complete examination. He was the first to show that the snow was not exactly placed at the poles of the planet. This is very apparent from our 3rd, 4th, and 5th figures, which have been very carefully drawn by Secchi; the first in 1856, and the two latter in 1858, with fine optical and atmospheric circumstances in his favour, and which,



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W. West, imp

in addition, show the seas and continents of the planet to great advantage. In those three instances the snow-zones were touching the margins of the planets, but in the second figure (taken by the writer on April 23, 1856, with the great Cambridge Equatorial) the south, or uppermost pole, was quite isolated. As a proof of the brightness of the snow-spots, it may be mentioned, that on this occasion, when a cloud passed over and completely obliterated the planet, the snow-zones were quite large and bright, and appeared like faint stars struggling through the mist.

Let us follow those spots through their regular changes. The planet comes into view on the Earth; the northern part, after a winter season about as long as one of our years, again receives the beams of the Sun. The patch of snow, as it appears to us, at first large, diminishes gradually, and finally vanishes. After having had the companionship of the stars and of the night for a great interval, and passed a long period under the dominion of darkness, the Sun appears, and to the protracted night succeeds the equally long day, with its fierce heat and light. Nothing occurs between the fiery summer and the bleak and dark winter; the other two seasons are wanting, but the one which is present amply makes amends for those which are absent, by the intense changes which take place in a comparatively short time. The Arctic seas, which were previously blocked up with solid ice or frozen snow, and have stopped the passage by sea and land, are gradually thawing; the Northern again becomes liquid, the snows melt, the ice passes into its primeval condition, the land becomes passable, and the Sun—the cause of all this commotion—keeps in sight all day long, as if to tyrannize over those whom it has previously, by its absence, subjugated. The air becomes clearer, fogs have disappeared, the seas and continents have apparently a clear atmosphere overhead,—if we are to judge by the facility with which we view them, the November mists and murky atmospheres have been succeeded by a dry air and sunny skies. The opposite changes take place in the southern hemisphere, whilst these variations are progressing in the northern. In the former, however, the extremes of heat and cold will be more severely felt. From the great eccentricity of Mars, the distance of the planet may vary between 131 and 158 millions of miles from the Sun; but when it is summer in the southern hemisphere, the Sun is nearest the planet; when winter, it is farthest from it. The quantity of heat and light received at those times by the southern portion of the planet are respectively 0·52 and 0·36; that of the Earth being 1·00. The consequence is, that the summers are hotter and the winters colder on the southern than on the northern hemisphere. This is confirmed by observation; for whilst the

northern patch of snow varies but slightly in dimensions, the southern is of great size in the winter, and almost vanishes in summer.

From the foregoing facts, and the deductions which may naturally be drawn from them, the reader has ample means for judging, in this individual instance at least, as to the probability of the planets being the abode of animal and vegetable life. It would be impossible, of course, to give any minute details on this point,—to say that such a place is forest land, or cultivated ground, or artificial formations; for when Mars is nearest the Earth—making use of the most powerful telescope yet constructed,—the observer is merely able to tell whether a space of ground which is two hundred miles long by two hundred broad, or an area of 40,000 miles, is round or square. From this circumstance, the observations of Schroeter, who saw clouds passing over the planet with a velocity from forty to sixty times that of the most violent hurricanes on the Earth, have been much doubted. But otherwise we have every evidence of an atmosphere, of snow, of changeable weather, of bright and sunny skies, of the existence of water. The seasons, though not so equable in duration as those on the Earth, are still present, with all their agreeable changes; we see the seed-time and harvest, the ripening summer and the dark winter. The isothermal lines on the Earth are reproduced on Mars, if we are to judge by the position of the snow-zones, which are not placed exactly at the poles. Nor does the excessive cold which might be surmised to take place from the planet's distance from the solar heat really appear to be so severe. Whether, from some peculiarity in the atmosphere, the latent heat of the body itself, or other causes unknown to us, the polar snows do not appear of the vast extent which might be imagined. Even those thaw away with a rapidity which seems marvellous, whilst the equatorial regions are altogether free from such visitations. Venus receives four times the heat of Mars, and twice that of the Earth; yet at the North Pole of Venus, a bright white and large spot has been perceived, which may naturally be surmised to be of the same nature as the snow-capped poles of the Earth and Mars; and we might from this conclude that no great difference exists in those three planets at least, whatever may be the case in the other two groups of planets,—*i.e.*, the seventy-six asteroids, or the huge exterior planets of small density, quick rotation, and accompanied by numerous moons and a ring.

The diameter of Mars is about twice that of the Moon, and more than one-half of that of the Earth. Its surface is about four times greater than that of the former, and is one quarter that of the latter. Bulk for bulk, Mars is seven times larger than the Moon, and the Earth is seven times larger than Mars.

Weight for weight, the Earth is more than seven times heavier than Mars. It would take upwards of two and a half millions of bodies like Mars to counterpoise the weight of the Sun. We thus see that Mars, with its diameter of 4,100 miles, holds a geometrical mean between the Moon and the Earth. The attraction, fall of bodies, and length of pendulum, are about one-half of what those are on the Earth. Unlike the latter body, it has no satellite, although, if this latter were thirty miles in diameter, it could not pass unnoticed.

Maedler has calculated the duration of the seasons in Mars, which are as follows:—

From Spring to Summer (Spring in North, Summer in South), 191 days.
„ Summer to Autumn (Summer in North, Winter in South), 181 „
„ Autumn to Winter (Harvest in North, Spring in South), 149 „
„ Winter to Spring (Winter in North, Summer in South), 147 „

It will thus be seen that there are 372 days of spring and summer in the northern, and only 296 days in the southern hemisphere. The winter in the north only lasts 147 days; in the south 181 days. The heat and light in the northern summer is as 20 to 29 to the south. The consequence of this will be, that there is a long temperate summer, and a short mild winter; whilst in the southern, there will be a short hot summer, and long and severe winter.

The sixth figure gives a map of one of the hemispheres of Mars, as drawn by Maedler, and shows what may be done by means of a small telescope. The seventh and eighth figures represent the opposite hemispheres of the planet as drawn by the writer on December 10, 9h. 20m., and November 22, 10½h. P.M., 1862. The spots in the seventh figure would appear to be the best defined of the planet, and bear a striking resemblance to those seen in 1719 by Maraldi, on August 19 and 20, and September 25 and 26, as also to that seen by Sir W. Herschel on October 10, 1783, at 6h. 55m. P.M.

MISCELLANEA.

THE BRITISH ASSOCIATION AT CAMBRIDGE.

PART I.

BY PROFESSOR D. T. ANSTED, M.A., F.R.S.

THE late meeting of the British Association, held during the first week of October in the University of Cambridge, has been one of those that may be regarded as successful, both in reference to the scientific men present and the communications made. It was not large, numbering only about 1,200 members in all; but the absentees, though including some well-known and familiar names, were chiefly the amateurs of science, associates, ladies, and those who join only for the current meeting; not working members, to whose labours the meetings are chiefly indebted for their important practical results. The sections were fairly attended, without being crowded, except on some few special occasions. The evening meetings were also well attended; and although the monetary returns will hardly be very brilliant, the reminiscences of Manchester and the prospects of Newcastle will console the treasurer for the comparative emptiness of the purse on this occasion. The Association meets one year for itself and another for the place it visits. At Cambridge, on the occasion of this, its third visit, there was not much enthusiasm, but there was a very pleasant assemblage of numbers of old members, who had been long without seeing one another, but who were not less warm in their greeting than if they had been annual attendants and had kept up acquaintance by frequent visits to the annual reunion.

An absence of excitement and "sensation" certainly characterized the meeting. The President (Professor Willis), in his address, rather recalled attention to the early labours of the Association, and the fruits it had borne years ago, than to the present state of science.

The evening lectures were on subjects already worn somewhat threadbare by frequent repetition at the Royal Institution, and were certainly not complimentary to the Cambridge audience. It is much to be regretted that Mr. Glaisher's interesting account of his balloon ascents did not replace one of these, and that a notice of recent researches in some interesting department was not introduced in place of the other. In spite,

however, of these mistakes, the meeting was pleasant and satisfactory, and the communications and discussions not unworthy of the occasion.

Of the different sections, that known as A—Mathematical and Physical Science—offers the greatest variety of subjects, and receives a number of communications that do not properly belong to it. Some of these should be considered in E (Geography and Ethnology), and others, perhaps, in B (Chemistry). It is no doubt difficult to determine in many cases in what way to limit so very general a term as Physics. Including Astronomy and Magnetism and, perhaps, Meteorology, it is apt to absorb Physical Geography. In something of the same way, B (Chemistry) and C (Geology) occasionally overlap. D (Natural History), if strictly confined to Biology, would be tolerably independent, though not unfrequently there are links connecting it very closely with Geology by the medium of Palæontology. Physiology is regarded as a branch of Natural History, and Statistics (F), of course, finds place everywhere. Mechanics (G) is tolerably well defined. Omitting any reference to Section D, which is in other hands, I propose to recall some of the principal and more interesting communications and discussions, not so much in a systematic outline as in a general statement.

Mr. Glaisher's balloon report, already alluded to, was the most attractive paper of the meeting, and certainly included all the elements of a popular lecture. As a meteorological communication, it was given to Section A. There were several other papers of interest, connected with meteorology, climate, and other departments of Physical Geography, about which we may say a word; some being communicated to Section A, and others to Section E. It is to be regretted that a better arrangement is not made with regard to such papers. At a scientific meeting, Physical Geography should certainly receive more consideration than Descriptive Geography and Travels, to which the geographical part of E has been mainly reduced, while Climatology—too important a branch of science to be neglected—ought not to be carried to general Physics, which is already too crowded with other matter more strictly belonging to it.

The balloon ascents of Mr. Glaisher are direct results of British Association work. It has long been felt, that to determine the condition of the upper part of the atmosphere, it was not sufficient to make observations on high mountains. In such cases we always carry the earth with us, and the mere existence of a mountain-chain is a serious cause of disturbance to the atmosphere. Even isolated conical peaks in detached oceanic islands are not satisfactory. On the other hand, the car of a balloon is not a very favourable station for observing; the work required to be done involves unusual accuracy and rapidity of observation, and the instruments used are very liable to injury in the descent. A large balloon, great precautions in managing it, and repeated experiments by practised observers, were indispensable; and these are not easily obtained. Moreover, the balloon is a costly instrument for experiment, and its use involves much danger to the inexperienced. The means, however, being furnished by an association grant of last year, an observer was found in Mr. Glaisher, than whom no man living is more fit for work of this kind.

It appears, also, that Mr. Coxwell has fully justified his reputation as

the first living aërial engine-driver. He is at once intelligent, instructed, and experienced,—sufficiently bold, but by no means reckless.

The number of ascents recorded is eight, and the average time in the air in each case was under two hours. The extreme height reached was above 30,000 feet; but there are no means of telling how much higher the balloon rose, as in this ascent Mr. Glaisher was, unfortunately, insensible from cold and exhaustion, during the critical time, and Mr. Coxwell was little better. The season of all the ascents was autumn, the dates ranging between the 18th August and the 8th September. The rate of ascent and descent was various, but sometimes extremely rapid, amounting to several thousand feet in a few minutes. The number of observations required to be made almost at the same moment, during the whole ascent, is enormous, but they seem to have been made with certainty, and without inconvenience, except at extreme elevations.

The conclusions arrived at, though only partial, were interesting and important; but they require confirmation and comparison with those made at another period of the year. The observations will probably be repeated in the spring of next year, and the results will be looked forward to with great interest at the Newcastle meeting.

Mr. Glaisher's account is graphic in the extreme, and the effects he saw on some occasions, when the balloon rose above a mass of clouds into the clear blue vault of heaven, are described as altogether surpassing in grandeur and beauty any cloudscapes visible from *terra firma*. This part of his narrative has, however, been frequently quoted in the daily newspapers and weekly journals, and need not be repeated.

Among the scientific results obtained by these balloon ascents are the following:—1. There seems no wind blowing steadily with any uniformity of direction in the upper regions of the air over our island at any height yet reached. 2. The clouds do not seem to form according to the contour of the land, but do seem to follow the tide up the great rivers. 3. The temperature not only does not decrease regularly as greater height is attained, but, in some cases, a very low temperature was attained near the earth, and was succeeded by much warmer air at a far greater elevation. 4. The aneroid barometer may be used with advantage, and may be depended on to any attained height. Mr. Glaisher states that it is available to a pressure of only five inches of mercury. 5. The humidity of the air diminishes rapidly, and at a height of five miles is extremely small. Several suggestions were made by various members in reference to aërial navigation generally, and the whole subject was recognized as of the greatest importance.

Memoirs were communicated on Climatology and Meteorological Instruments by Mr. G. J. Symons, Mr. Plant, Professor Ansted, Dr. Gladstone, Mr. Galton, Mr. Lowe, and other members. Some of these were of much interest, but we have not space to allude further to them. Mr. Lowe's paper on Ozone was especially valuable, and included the description of a new Ozone box, showing some interesting results.

The structure of the sun's surface and the volcanoes of the moon were the subject of several communications. Mr. Nasmyth pointed out some recent observations tending to prove that the sun's nucleus is dark and dense;

the light emanating from an outer envelope of lenticular filaments, not distributed in symmetrical order. He estimated these filaments at about 1,000 miles long by 90 miles broad, and stated that they move among themselves with enormous velocity, separating to form spots, and filling in to obliterate them. They are regarded by Mr. Prichard as solid. Some admirable representations of lunar volcanoes were exhibited and described.

On the whole, not less than seventy-six communications were referred to Section A, this being more than one-fourth part of all memoirs received, and more than double the number read at any section but Geology. Of these, at least twenty were strictly meteorological, and belonged much more to Physical Geography than to General Physics. In Section E (Geography and Ethnology, including Archæology) there were in all only twenty-eight memoirs, and of these only four related in any way to Physical Geography, while seventeen were mere narratives of travel.

In Section B, the communications were not of popular interest, and were chiefly technical. There was, however, one paper, by Mr. Lawes and Dr. Gilbert, on the subject of Manures and their action on grass land, interesting to the agriculturist. Many of the geological communications and discussions were also technical; but, as usual, there was a sufficient sprinkling of popular matter to attract strangers and ladies. Perhaps the most interesting novelty was the notice of Dr. Falconer's pigmy-elephant bones, of which some were obtained, three years ago, from a cavern in Malta, by Captain Spratt, R.N., and retained quietly by Dr. Falconer till a sufficient number of specimens had been received to decide every point of structure. There was something unusually interesting in the result of this reticence. Instead of the usual announcement of a new species from a single tooth or fragment of a bone, Dr. Falconer, as soon as he obtained the first instalment of news regarding so curious a variety, simply put his specimens by, and urged his friend, Captain Spratt, to search for and send more. He sent more; but, still, other bones were wanted; and, at last, in this way, a series was got together which really left nothing to be desired. Then our cautious Doctor, who has made elephants his special study, found himself in a position to bring down to the Association a perfect *embarras de richesses* in reference to this new form. He has bones and teeth of individuals of all ages, and, comparing them with corresponding bones and teeth of the Indian or fossil species, he exhibits all the peculiarities of structure. This pigmy was, when full grown, about the size of the Malay tapir, but was in all respects a true elephant in structure, having tusks and teeth in all respects elephantine. It inhabited Southern Europe up to a comparatively late tertiary period.

The drift question and the deposits of loose and alluvial mud in the bed of the Rhine and other rivers,—the gravel, and its connection with the glacial period, and the facts of chief interest in reference to this question, were the subject of many papers and of some very interesting discussion. This department of Geology is now clearing itself, and, before very long, will afford the latest, and probably the most instructive, chapter in all geological works. It still remains surrounded with difficulties; but they will disappear one after another, and we shall then be able to connect the present with the past.

The subject of coal was introduced by Professor Ansted in two papers,—one referring to a newly-discovered tertiary coal, of excellent quality and strictly bituminous, found in Hungary; and the other pointing out the difference between coal with bituminous schists. Dr. Sterry Hunt also made a communication on the subject of the Rock Oils of North America. But little discussion followed, and the question as to the origin of coal was not gone into. The discussions generally in the geological section were somewhat tame. Mr. Sorby communicated a very interesting addition to his observations on the structure of shells, pointing out that certain parts of the animal and certain animals habitually deposit carbonate of lime in the shape of *aragonite*, while other animals, and some other parts, deposit *calcite*. The aragonite form is not, however, so permanent as that of calcite, and hence it is apt to disappear or pass into calcite during fossilization.

Section E did not present much that was new. Sir R. Alcock, on Japan; Sir C. Nicholson, on recent explorations in Australia; Captain Burton and Mr. Jules Gerard, on African discovery,—all promised well, but failed to keep up the interest their subject matter seemed to offer. There was, however, an interesting communication by Mr. J. Wright, on an archæological subject, started at the Oxford meeting, arising out of the excavations on the site of the ancient Roman city of Uriconium, on the borders of Wales. Numerous human remains were there discovered, and of some of these the skulls are strangely and systematically distorted. As all the regular interments within the walls consisted of bodies that had previously been burned, the persons whose skulls remain were probably destroyed when the city was sacked and burned. The skulls of the Roman inhabitants seem not to be injured, but buried in a spot supposed to be an entrance to the town, and under circumstances which seem to show that they are certainly not older than the Roman period, and probably not much newer. There were found eleven skulls, seven of which were singularly and uniformly deformed, having an unnatural twist, which causes one eye to advance beyond the other, and gives an obliquity to the face. The cause of this has not yet been determined.

Several communications of great interest were made in Section F (Economic Science and Statistics). Among the most important, both for subject and treatment, may be mentioned one by Mr. Vernon Harcourt, on scientific evidence, and two or three, by competent authorities, on the course of studies and the expenses of student life at the University. Valuable and lively discussions took place with reference to all these.

It has long been felt that the position of a man of science called on to give evidence in a court of law is difficult and unsatisfactory. He receives his instructions and information on the question at issue from one side, and as there are few subjects that do not admit of two opinions, he naturally and inevitably makes the best of the case put before him. To some extent, he thus becomes an advocate, and his real judgment is biassed. It was proposed by Mr. Harcourt that, in place of scientific evidence, as now received, skilled assessors should be appointed by the judge on application, and that they should give their opinion in writing. Mr. Whiteside, Q.C., while admitting the necessity of some change in the

present system, perceived practical objections to the appointment of assessors. The matter was referred back for reconsideration.

The studies at the University, the distribution of University and College rewards, and the cost of University education, came also under consideration. It is undoubtedly the case that, up to the present time, the effect of the new measures recently introduced has been very small, so far as Cambridge is concerned. The Natural History sciences are, indeed, acknowledged, and examinations are held, at which those who have graduated may test their progress; but hitherto these are not the subjects for which scholarships and fellowships are granted. The general feeling in the University, and among University men, is not favourable to any fundamental and rapid change. It is fortunate that such is the case. The time has not come when Englishmen are to regard mere *cram* and the acquisition of facts, however important, as taking the place of cultivation of the intellect; and at present, at any rate, there is no department of science, not admitting of mathematical expression, that can be regarded as equivalent to the study of pure mathematics and grammar in preparing the intellect for the subsequent work of life, in the pulpit, at the bar, in medicine, or in the House of Commons.

The Mechanical Section (G) was attractive and the papers important. It would be difficult to present a more admirable and practical illustration of the value of pure mathematics to practical men than that offered by the Astronomer Royal in this section, when illustrating the nature and direction of the forces concerned in the case of a tubular latticed bridge with a train crossing it. By a masterly resolution of a very difficult problem in pure mathematics, he showed how a set of extremely simple formulæ were deduced, which led to direct practical conclusions identical with those obtained by series of experiments, numerous, costly, and dilatory, by which alone our great mechanicians had practically determined the ordinary rules-of-thumb. The parts of the bridge that might with advantage be left weak, those where unusual strength was needed, and the necessity of enormous strength in the piers supporting the two ends, were illustrated in a simple diagram. Mr. Fairbairn and Mr. Scott Russell, who represent all that is most intelligent and bold among mechanicians, explained to the meeting the curious processes by which each for himself had worked at the mathematical problem in vain, and had then, by a series of trials, obtained, by an exhaustive process, a result resembling that here given. It would not be possible to show a more interesting and instructive example of the application of high mathematics to resolve a difficult practical problem.

A memoir on Artificial Stones, by Professor Ansted, was the means of directing attention to a new material recently introduced by Mr. F. Ransome. This stone is so very easily and cheaply made, of any rough mineral matter that may be at hand, the process is so extremely rapid, and the resulting material is so uniform in its texture, moulds so admirably, and presents so smooth a face, that it is likely to supersede terra-cottas and cements. It is a curious instance of an important discovery arising out of experiments in another direction. Endeavouring to prove that he was able to preserve decaying stone, the inventor found

himself manufacturing a substance that might well replace decaying stone. It is already being made on a large scale, some of the work of the stations of the Metropolitan Railway recently opened being constructed of it.

It may well be supposed that unsinkable ships, projectiles and guns, and iron plates, would not escape discussion. Much good sense was shown in discussion, but there did not seem any very new views, the general conclusion being that the gun, as at present used, can throw a projectile that shall penetrate any armour hitherto made.

Two excursions were made during the meeting. One, by the Geologists and Naturalists, to Hunstanton, in Norfolk, where there is an interesting cliff showing the bottom beds of the chalk, and the rocks coming out from beneath, and where some good fossils have been obtained. The other was by the Mechanical Section; the object being to see the works now nearly brought to a conclusion that are intended to remedy the evils caused by the recent destruction of the Middle Level sluice and the flooding of the Fens. A few hours after the party had left the Fens, another similar accident occurred, on a smaller scale than the first accident; but still one that it would have been interesting to witness in its early stages.

The work of the general committee at the meetings of the Association involves the confirming the suggestions and reports of the council and the committees of recommendations, and the selection of the place of the next ensuing meeting. The money grants made at Cambridge were somewhat large, amounting to nearly £2,000. Of this sum the Kew Observatory, as usual, absorbs the lion's share. There is, perhaps, no work undertaken by the Association that has borne better or more important fruit than that connected originally with Terrestrial Magnetism, and afterwards carried over all departments of Meteorology. When the Association was originated at York, in 1832, the science of Meteorology was barely recognized. It has grown and flourished under the auspices, and has always been an *enfant chéri*, of the governing body at each successive meeting. Terrestrial Magnetism and Meteorology are, indeed, the branches of modern science that owe most to the Association; and when we say that nearly £1,000 were appropriated, at Cambridge, to keep up the Kew establishment and assist in investigations in the department of physics, including balloon observations, it will be evident that there is no falling off in this direction. Other grants are by tens, but these by hundreds; and, so long as there are no other means available, it is fortunate for the reputation of British science that such is the case.

The position of the Association has greatly changed since the time when its meetings (then, at most, amounting to a few hundred members) were greeted with ridicule, and when its efforts were regarded as useless. It has long since fought its way to a position which enables it to command the attention of the Government when any important scientific object is to be attained, and by its Parliamentary Committee, and its Permanent Council, acting in concert with the Royal Society, it has already done much good. That the direct results have not been even greater, is not because its members have been idle. It is but a short time since the reasonable

demands of scientific men for grants of public money to carry on investigations of pure science were first seriously listened to. They are now rarely refused, and this has arisen from the development of a combined action, mainly induced by the meetings of the Association and the bringing together of men from all parts of the country, earnestly and honestly pursuing similar investigations and discussing, with perfect freedom, the bearings of every question brought before them. A voice of this kind could not but be heard; and as the meetings have now been held, not only in each University, more than once, but in most large towns throughout the kingdom, and the members have always been received with open arms as public benefactors, their recommendations coming continually with more and more force.

We have endeavoured to show in these few remarks that the variety of subjects embraced at the meetings is as great as the spirit of the Association is catholic. The range is, indeed, widening rather than narrowing, and this in spite of the vigorous branches that have been thrown off from time to time. There is, beyond all doubt, a spirit of vitality and an amount of energy developed that show no symptoms of decay; and as the original members, now old, are being well replaced by younger men rising into distinction, it is to be hoped that the stage of doubtful and weakened activity that supervenes on all societies when the founders suddenly quit the field and their successors are hardly familiar with their work, is now well passed, and that a long and useful future may be anticipated.

PART II.

SECTION AND SUB-SECTION D.

ZOOLOGY, BOTANY, AND PHYSIOLOGY.

BY DR. COLLINGWOOD, F.L.S., &c.

At the opening of this Section on Thursday morning, October 2nd, the President, Professor Huxley, F.R.S., delivered an excellent address of one hour's duration, selecting for his subject, "The Condition and Prospects of Biological Science." Biology is the science which investigates the nature and relation of organized beings, and that comprehensive subject he divided into the following sub-groups. 1st, *Morphology*, or the doctrine of form and structure, including the almost new science of Development, for which we were chiefly indebted to the Germans; Anatomy and Histology, or the anatomy of the tissues; and Taxonomy, or the systematic classification of plants and animals. 2nd, *Physiology*, which takes cognizance of the vital functions, sustentative and generative, performed by organic beings. 3rd, *Distribution*, whether in time (Palæontology), or in space (geographical distribution). 4th, *Ætiology*, or the laws of origination and variation, including the physiology of direct and indirect conditions. These were the objects of the science, and taking

up each, *seriatim*, he dwelt upon the progress they had respectively made in the last half-century,—a progress which exceeded that made in all previous time; and would probably during the present generation yield still more startling results. In speaking of the laws of origination and variation, he referred to the work of Mr. C. Darwin, "On the Origin of Species," a work which he said was "as perfect in its logical method as it was accurate in its scientific facts," though he did not pledge himself to all Mr. Darwin's results. In conclusion, he stated that he felt bound to make use of his present position, to urge upon the University authorities the claims of biology as a recognized study, and the practical encouragement of it by the bestowal of some of those fellowships which were so ungrudgingly given for proficiency in mathematics and classics.

As Professor Huxley had included both Universities in his appeal, Dr. Daubeny, F.R.S., rose, and stated that at Oxford such fellowships were given for natural science, as he could affirm (from his own knowledge) to be the case, at least at Magdalen College, to which he belonged.

Rev. William N. Molesworth, M.A.: "On the Influence of Conditions of Existence in modifying the Characters of Species and Varieties." The author said that a theory which should combine all the observed facts of palæontology, distribution, &c., and scientifically grapple with the origin of species, had long been a desideratum; and, although he wished to appear neither as an advocate nor an opponent of Darwin, he believed that that gentleman had been unjustly accused of making a wanton attack upon beliefs and feelings which ought to be respected. He condemned the introduction of scriptural matters into scientific investigations, and urged that science need never come into collision with moral and religious truth. He thought, however, that there was a point on which Darwin might have laid more stress, viz., upon the changes which were continually taking place in the conditions of animal existence, and the necessity of the variations which arose out of those changes; so that the being might be able to keep in harmony with the conditions of its existence.

The Rev. Professor Kingsley entirely concurred, as a brother clergyman, with what Mr. Molesworth had said about the ill-founded charge of materialism which had been made against Mr. Darwin.

J. Crawfurd, F.R.S.: "On Colour as a Test of the Races of Man." Colour, in different races, appeared to be a character imprinted upon them from the beginning, because, as far as our experience goes, neither time, nor climate, nor locality has produced any change. Egyptian paintings, 4,000 years old, represent the people as they are now. The Parsees of India, who went from Persia, are now the same as when they migrated 1,000 years ago. African Negroes, that have for three centuries been transported to the New World, remain unchanged. The Spaniards settled in tropical America remain as fair as the people of Arragon and Andalusia. He contended that climate had no influence in determining colour in different races. Finns and Lapps, though farther north, are darker than Swedes; and, within the Arctic circle, we find Esquimaux of the same colour and complexion as the Malays under the equator. Yellow Hottentots and Bushmen live in the immediate neighbourhood of black Caffres and Negroes. There is as wide a difference between the colour of an

African Negro and a European, between a Hindoo and a Chinese, and between an Australian and a Red American, as there is between the species of wolves, jackals, and foxes.

Sir Charles Nicholson could not agree with Mr. Crawfurd's conclusions. The variety of the human races, as they now are, has, doubtless, existed for a long time; and tombs of very great antiquity showed this. But there is now in India a race of Jews perfectly black; and in China, the Jews had long become the same in physiognomy with the Chinese, though the Jews never intermarry with them. Among the natives of America there is an evident approximation to the Red Indian in physiognomy, for they were assuming the hatchet-face, and losing the beard. The same effect could be discerned among the European population of Australia; and Sir Charles stated his opinion that the question was to be settled on philological rather than on ethnological grounds. (The black Jews, to whom Sir C. Nicholson referred, are well known to be the descendants of Hindoo proselytes, and not of Jewish extraction, and they look up to white Jews as to a superior people.)

The discussion of greatest interest in this Section was raised upon a paper, by Professor Owen, F.R.S., "On the Zoological Significance of the Brain and Limb Characters of Man; with Remarks on the Cast of the Brain of the Gorilla." The Professor exhibited two casts; one of a human brain hardened in spirits, the other taken from the *interior of the cranium* of a gorilla,—and described the peculiarities of each. He remarked that these were so marked as clearly to distinguish them generically. In the brain of man the posterior lobes of the cerebrum overlapped the cerebellum (or smaller brain) to a considerable extent, whereas, in the gorilla, these posterior lobes did not project beyond the lobes of the cerebellum; that is to say, that in man the posterior lobes were prominent, whereas in the gorilla they were deficient. From long and close investigation into the characters of animals, he was convinced that the *brain* offered the most constant characters; and he had, therefore, proposed, in a paper read before the Linnæan Society, in 1858, to recast the mammalian groups—classifying them according to their cerebral development. Man, besides having a remarkable prominence of the posterior lobes, also possessed a part termed a *posterior cornu*, or horn, of the lateral ventricles, and another portion, termed the *hippocampus minor*, in this posterior cornu. The distinctions between this type of brain and that found in the other mammalia were so well marked that he had placed man in a distinct sub-kingdom. The brain he considered a far better guide in classification than the foot; but, nevertheless, as great difference was observable in the latter as in the former.

Professor Huxley said that the paper just read in no way appeared to represent the real nature of the question under discussion, which he would state in another way. That question was twofold—one of facts, viz., What are the structural differences between man and the higher apes? and one of reasoning, viz., What is the systematic value of these facts? Professor Owen had now for several years made three distinct assertions respecting the first question of facts,—assertions which he had repeated in the present paper. These assertions he had reiterated without modification or

qualification of any kind. He (Professor Huxley), on the other hand, affirmed that the three assertions of Professor Owen were groundless, inasmuch as the three structures spoken of were, instead of being *peculiar* to the human brain, often *better developed* in the higher apes than in man. He deprecated the present discussion as useless and full of evil, but he was bound to take up the challenge that had been thus thrown down to him. He believed, however, that the differences between man and the lower animals are those of the moral and intellectual faculties, and are not to be expressed by physical differences in his toes or his brain.

Professor Rolleston, F.R.S., said, it had been abundantly shown that the *hippocampus minor* and the posterior lobe were insufficient as differential points, and must be given up at last. He regretted that the labours of Gratiolet had been ignored in this discussion, a circumstance little creditable to British science. He had proved that the differences between the brain of man and the ape were: 1st, its greater absolute weight; 2nd, its greater absolute height; and 3rd, the multifidity of the frontal lobes corresponding to the forehead, usually (and correctly) taken as a fair exponent of man's intelligence. It was to the *front* rather than to the back of the brain that he should look for the distinguishing characteristics of man. But Professor Owen had made no allusion to these important matters.

Mr. W. H. Flower, F.R.C.S., conservator of the museum of the College of Surgeons, said that, looking at the subject solely from an anatomical point of view, and as a question of fact, the result of his dissection of a larger number of monkeys' brains than had perhaps fallen to the lot of any one else present was, that the parts referred to by Professor Owen as peculiar to man are, in reality, proportionately *more largely* developed in many monkeys. If these parts were to be used in the classification of the mammalia, the series would be,—first, the little South-American marmosets; next the baboons; then the cercopithecs, the magots; *then* MAN, followed by the orang-outang, chimpanzee, and gorilla; and last the American howling monkey.

Dr. Humphry thought that slight difference of structure might lead to vast functional results, and that a moral hiatus might be greatly out of proportion to any mere physical distinction.

After a few words from Professor Owen, in reply to Professor Rolleston, the discussion ceased.

(During this discussion the writer had an opportunity of examining a dissected brain of a cercopithec in spirits, which Mr. Flower chanced to have with him, and in which the posterior cornu and hippocampus minor were very distinctly visible.)

Mr. James Samuelson: "Recent Experiments on Heterogenesis, or Spontaneous Generation." The author communicated the results derived from the simultaneous exposure of various kinds of infusions prepared by him in Hull, Paris, and Liverpool. Amongst these results the following afford fresh evidence against the theory of spontaneous generation, and tend to prove the existence of innumerable germs of life in the atmosphere.

Dr. Balbiani (the author's coadjutor in Paris) found certain well-defined species of infusoria in his infusions, which he also discovered in the moistened dust from his window; and another well-marked species, found

in large numbers by Dr. Balbiani in his infusions in Paris, was traced by Mr. Samuelson, first in moistened dust from the high road near Liverpool, then in dust taken from his own window and washed in distilled water, and lastly even in pure, boiled, distilled water, after it had been exposed a few days, in the open air, in Liverpool. The author watched and carefully described the development of this species (*Cercomonas acuminata*) from its first appearance to its full growth. These experiments will, we believe, be published shortly, with illustrations.

Dr. Davy, F.R.S.: "Observations on the Earthworm." These observations went to show that the coloured fluid, or blood of *Lumbricus terrestris*, served for the purposes both of nutrition and aëration or respiration, and were confirmed by a series of experiments. Dr. Davy considered the blood to be a receptacle for oxygen, which is stored up in it to supply the requirements of the worm.

Dr. Cobbold, F.L.S.: "Remarks on all the known Forms of human Entozoa." The author exhibited drawings, and described the structure, habits, and mode of development of thirty species of intestinal parasites which infest the human body; one of these (*Bilharzia hæmatobia*) was common to man and monkeys, exclusively. He showed the possibility of checking the progress of several fatal entozöotic diseases, and he appealed to this Association to aid him in experimental research upon this important subject; and described the enormous destruction of human life in Iceland, arising from the introduction of entozoa into the body. (Subsequently, in the Committee-Room, a committee was appointed, and a sum of money voted for the investigation of this subject.)

Dr. Collingwood, F.L.S.: "Report of the Committee for advancing Science by means of the Mercantile Marine." The writer stated that the paper read by him at Manchester: "On the Opportunities of advancing Science enjoyed by the Mercantile Marine," and then ordered to be printed, had been extensively circulated in England and America, and was furnished by the direction of the Committee of Council on Education to all the Government Navigation Schools. The Literary and Philosophical Society of Liverpool had created a new class of members, termed *Associates*, to include captains and mates of merchant vessels, as an encouragement and reward of any endeavour they might make to advance science; * and meeting of the leading shipowners of that port had had the subject laid before them, and had approved of the suggestions which had been made. A publication addressed to the members of the Mercantile Marine had been issued by the same society, containing plain and concise directions how to study, and how to preserve the animals which came under their notice, with a reference also to the most useful books, and most simple apparatus for that purpose. It was intended to circulate this pamphlet among the officers of merchant vessels; and it was hoped that important results would follow in course of time.

The subject of this Report was then discussed by Professor Huxley,

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* We would recommend the Society to add to the honour thus conferred a more tangible reward, such as a medal.

James Heywood, F.R.S., Dr. Lankester, F.R.S., Rev. H. B. Tristram, and others, the speakers all agreeing in the importance of the movement, and expressing their satisfaction at the progress it had made in the hands of the writer of the Report.

George D. Gibb, M.D., F.G.S.: "On the Physiological Effects of Bromide of Ammonium." The author felt justified, by his experiments, in saying that not the least important of its properties was its power of *diminishing* fat in the animal economy. He believed that its action in the diminution of corpulence and its allied states would be ultimately found of more value than the *Fucus vesiculosus* (seaweed), or any other substance at present known.

John Davy, M.D., F.R.S.: "On the Scientific Cultivation of the Salmon Fisheries." Dr. Davy showed how these fisheries had been neglected in this country, and pointed out the manner in which they should be improved. While in Ireland the annual value of salmon fisheries was £300,000, and in Scotland one single fishery, belonging to the Duke of Richmond, was valued at £12,000; the total value of the English and Welsh fisheries was only £10,000. Dr. Davy proceeded to describe the improvements made at Galway, by means of which, in ten years, the fishery had been rendered ten times as productive; and 3,000 fish had been taken with the rod during the present season. The preservation of the stream *during the breeding season*, at a cost of £500, had chiefly led to this result, aided by the introduction of young artificially-bred salmon, into streams fitted for them, but from which the fish had been previously excluded, owing to impediments preventing their access to the sea. These impediments had been removed by the construction of ladders; by means of which, in Sligo, for example, a fall of forty feet had been rendered easily surmountable by the salmon, so that, by this means, a previously barren river had been made to yield, in one week of July last, 1,000 fish.

Professor Kingsley and Professor Huxley commented upon the importance of this subject, and remarked that there was no reason why salmon should not be the abundant fish and the valuable article of diet to the lower classes that it had been in days gone by.

Dr. Davy also read a paper "On the Vitality of Fishes," which our limited space prevents us from reporting.

Gilbert Child, M.D.: "On Marriages of Consanguinity." Distrusting the ordinary statistical mode of examining the question, he believed that experiments on the lower animals were conclusive in proving that degeneracy did not result from in-and-in breeding. He held that there is positive evidence, from the results of recorded observations upon animals, that no such law affects them; that is, that where other causes of degeneracy are absent, any degree of close breeding may exist, without producing ill effects; and he argued, that unless we are prepared to believe in two distinct physiologies, the same must be true of the human race.

The President, Dr. Paget, opposed these conclusions, as being contrary to fact; and denied that the comparison between the lower animals and man in this respect held good.

Dr. Gray, F.R.S.: "On the Change of the Form of the Head of Crocodiles, and on the Crocodiles of India and Africa." Confusion has arisen

among the species of crocodiles, from the error of some naturalists regarding the young and the adult as different species—an error arising from the short and rounded form of the face when first hatched. In process of growth, however, the muzzle elongates, and the bones increase in size for supporting the teeth. The author remarked that this well illustrated the necessity of studying all the kinds of animals in every stage of their growth. No species could be said to have been properly observed until all these circumstances had been duly examined and noted; and though the notice of a single individual, or state of an animal, was certainly of value, it could only be regarded as a sign-post, indicating the existence of an animal which required further study and examination. Dr. Gray went on to point out that great confusion had arisen among the species of Crocodiles and Alligators. The character of the "teeth fitted into notches in the margin" was one, however, which was peculiar to crocodiles, and not common to both; nor is the African crocodile found in India, as supposed.

R. Garner, F.L.S.: "On Pearls: their Parasitic Origin." Mr. Garner had examined the pearls formed in the Conway and Lancashire mussel; not the beautiful pearls of the Alasmadon, from the Upper Conway, at Llanrwst, but those of the salt-water mussel. He attributed the same origin to all pearls, viz., the deposit of eggs by a minute species of Distoma, causing their formation much in the same way as galls are formed in plants.

Dr. Cobbold was not ready to accept Mr. Garner's explanation, for he had not seen the Distoma within the pearl, nor investigated the anatomy of the parasite; and knew not, therefore, whether it was a perfect Distoma or a larva.

Mr. Garner replied that the pearls of Alasmadon are not diseased ova, for it has its ova in the foot and gills, where the pearls do not occur; nor are they produced in the renal organs. They might be produced by grains of sand, &c., but then such foreign bodies could not get access to the mantle, as it is attached all round to the shell; and on splitting a pearl no grain of sand is found, but a little dark-coloured animal matter, which he considered to be the remains of the Distoma, its exuviæ, &c. In the Lancashire mussels, the Distoma was always to be found as a little yellow speck (to the naked eye) enclosed in a condensed cellular envelope, and sometimes might be found in a calcifying state. He did not think he was called upon to follow out the anatomy of the parasite.

Professor Rolleston, F.R.S.: "Diastase in the Saliva, and its Action upon Starch and Inuline." Inuline, a kind of starch found in the dahlia, artichoke, &c., differs from true starch in not being changed into sugar by the converting agency of the diastase contained in the saliva, unless, indeed, it contains sugar at first. Moreover, the saliva of infants contains so small an amount of diastase, that even common starch is inconvertible by it, and therefore innutritious. Important practical results follow from this; first, that artichokes cannot be used as a substitute for potatoes, since they contain inuline instead of starch; and second, starch foods are useless in the early months of infancy, since the salivary diastase at such a period is inactive.

SCIENCE SCHOOLS AND CLASSES.

In the List of Science Teachers contained in our last Number we mentioned the name of Mr. H. P. Meaden, Haslingden, near Manchester, as having passed nine students with first-class Queen's prizes.—It should have been ten.

We have to add that before the last examination there were 158 Science Teachers in Great Britain, and four Lecturers holding honorary diplomas. Their names will be found at the end of the last Directory published for the Science and Art Department, South Kensington Museum.

We mention this, as we know of persons who have been desirous of obtaining instruction in elementary science, and were quite unaware that there was an able teacher resident in their immediate vicinity.

REVIEWS.

BRITISH CONCHOLOGY.*

AT the commencement of his volume, Mr. Jeffreys refers to the expensive character of the "British Mollusca," by Professor E. Forbes and Mr. Hanley, as a reason for his having undertaken the present work. No such apology was needed: naturalists who know anything of the enthusiasm of the author for his subject, and of the zeal with which, for many years, he has devoted himself to his favourite study, would have had cause for much regret if the materials thus collected had been withheld from the public, or were only to be found scattered in the many communications made by him to various scientific societies.

To afford some idea of the research undertaken in preparation for the present work, we may refer to the author's account of his investigations relating to a single genus of small fresh-water bivalves:—

"My own cabinet contains no less than 274 parcels of *Pisidia*, which have been in the course of the last thirty or forty years collected from different localities and sources, and comprise many thousands of specimens. I have personally examined the types of those species which have been described by Dr. Turton, Mr. Jenyns, Mr. Alder, Dr. Bandon, and other conchologists who have published on the subject. I have collected these tiny shells in many parts of Holland, Germany, France, Switzerland, and Italy, for the sake of comparison with British forms; and I have had to refer to numerous works in many languages in order to collate the descriptions of forty-one different species which have been proposed by European writers within the last century. Of these I cannot conscientiously recognize more than six as distinct."

Although the volume now published is confined to land and fresh-water shells, the Introduction, extending to 114 pages, is quite general, and affords space for the description, in a very readable form, of most of the questions interesting to conchologists. Without expressing a decided opinion on the "origin of species," Mr. Jeffreys suggests a practical method of distinguishing between species and varieties. He says:—

"I believe it may now be considered a well-established rule that all distinct groups of individuals, living together, and having a common feeding-ground, and which are not connected or blended with each other by insensible gradations, are *primâ facie* entitled to the rank of species."

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* *British Conchology*. Part I.—Land and Fresh-water Shells. By John Gwyn Jeffreys, F.R.S., &c. Van Voorst. 1862.

Selected on this principle, the author recognizes 121 species of British land and fresh-water molluscs; the number given in the "British Mollusca" being 125. This slight reduction in the number of species accredited to our native land is, however, far more than compensated for by the acknowledgment of no less than 187 distinct varieties, all of which are named and described; whilst, of a large proportion, the localities and other circumstances of interest are recorded.

The name of a new species had, until recently, something almost magical in its attractions. Collectors were deemed fortunate who could secure the prize; its absence from a cabinet was regarded as leaving an unsightly gap; whilst varieties, however curious or distinct, were counted as little more than superfluous luxuries. Thanks mainly to Mr. Darwin, this disparity is at an end, and collectors are now in a position better to appreciate the value of labours such as those of the author, and of the large increase he has made in the number of recognized objects of attention on the part of those who desire to study the land and fresh-water shells of our country.

In the more difficult genera Mr. Jeffreys has, we think, succeeded in presenting the species in bolder and better relief than any previous writer. For example, the genus *Zonites;* the descriptions of *Z. nitidus, Z. alliarius, Z. purus, Z. nitidulus, Z. radiatulus,* ought to leave collectors in no difficulty in identifying these snails, even without the assistance of plates.

In nomenclature the author seems to us in a few instances to have needlessly increased the difficulty of the subject by the adoption of unfamiliar names, having only a questionable claim to priority; and by alterations in orthography induced by his desire to render all the generic names significant. A mere name is at all times a most fallacious guide to the determination of a species, and young collectors, to whom alone the caution need be addressed, should in no instance affix a name on account of its supposed agreement with a specimen under examination. It is far more honourable, and in every way better for scientific purposes, to attach the place, date, and, if possible, the circumstances of its capture, and to wait patiently till it can be satisfactorily identified.

In the work before us, for *Balea* of Dr. Gray, the more recent *Balia* of Swainson is adopted, as nearer "badius," a somewhat barbarous Latin word for "brown," which is, after all, a wholly unimportant indication. If the supposed meaning of a name is to give a clue to its orthography, we can well imagine the erudition which may hereafter be called into exercise by future conchologists pondering upon such titles as those of Dr. Gray's genera "Lottia" and "Pollia," the investigators being, after all, certain to hit upon no meaning half so pleasant as the fair originals.

In one instance Mr. Jeffreys has for a well-established name, "*Pupa Anglica*" of Ferussac, substituted one of his own, "*Pupa ringens*" Jeffreys, on the plea of having been the first to describe the species, though previously figured under the familiar name; and this whilst, on his own showing, the name *Pupa ringens* had been used by M. Michaud for another species of the same genus. All possible consideration will, however, doubtless be extended to the author when it is understood that the

vindication of his own discoveries presents itself to him in the aspect of a "parental duty" (p. 267).

In many respects the present work appears to us to be far in advance of any previous one upon the subject. Together with clear, concise, and sufficient descriptions of the characters which serve to distinguish the species, are combined so many interesting observations on the habits of the animals, that the work possesses the rare merit of combining scientific accuracy with a large amount of popular instruction. We can only give one or two brief illustrations. It is well known that certain univalves, when suddenly dislodged from floating weeds, spin a thread by which, like the spider, they are able to regain their resting-places. Mr. Jeffreys records a similar habit in *Sphærium lacustre* (*Cyclas caliculata*), which also uses its foot in ascending the sides of an aquarium, and even in creeping along, suspended from the surface of the water, just in the manner common to many gasteropods. Bivalves, with the exception, perhaps, of some species of oyster, are supposed to be purely aquatic in their habits; yet the author records, on the authority of Nilson, that *Pisidium pusillum* is in Sweden frequently found living between the bark and the wood of fallen trees in moist places. *Helix pulchella*, a minute snail common in Britain, is reported to occur in Siberia, Italy, Corsica, Madeira, North America, Cashmir, and Thibet. Some of our little wood-snails, *H. aculeata* and *H. fusca*, appear, on the Continent, to adopt habits not generally known in this country: they ascend in spring the trunks of trees, live during the summer amongst the higher branches, and in the autumn save themselves a long and laborious descending journey, by dropping with the falling leaves to their place of winter retreat.

The snail has not generally found much favour in the eyes of poets; yet the author avails himself of the assistance of a friend to devote some pages to the æsthetic aspect of his subject, with especial view, as he asserts, to the gratification of his fair readers. Homer, Göethe, and "Shakspere," are cited. From the "Venus and Adonis" of the last-named a fine simile is given:—

> "Or as the snail whose tender horns being hit,
> Shrinks backward in his shelly cave with pain,
> And there, all smother'd up, in shade doth sit,
> Long after fearing to creep forth again;
> So at his bloody view her eyes are fled
> Into the deep dark caverns of her head."

We anticipate with pleasure the volumes on the "Marine Mollusca of Britain," by the same author, and conclude this brief notice with a word of commendation for artist and publisher. Mr. Sowerby's plates, more especially the beautiful coloured frontispiece, deserve special notice; and of Mr. Van Voorst we can only repeat what has been said a hundred times before,—that what ink and paper can do to render useful reading pleasant, he has done.

WASTE PRODUCTS AND UNDEVELOPED SUBSTANCES.*

AT the present period, commerce is making such demands for increased supplies of various substances, that scientific men are carefully studying the residue of every manufacture, and the special qualities of each new product. At such a time, then, a book like the one before us is of peculiar value, and we have read with much pleasure and interest this work of Mr. P. L. Simmonds on Waste Products and Undeveloped Substances, a book aptly described by the author as affording "hints for enterprise in neglected fields,"—hints which do not refer so particularly to waste materials, but serve specially as directions by which to guide the student into new fields of inquiry as regards the utilitarian applications of natural productions generally. It would be difficult to define what is "waste" in the present day, so admirably and completely are the many substances, formerly neglected and thrown away, now utilized and converted into new and valuable products. A greater field, however, for the commercial as well as scientific inquirer is that afforded by undeveloped substances. It is now, when the word "substitute" is ringing like a battle-cry, that men's thoughts are directed to every variety of produce; and week after week vessels bring from different quarters of the globe woods, containing new tints for the dyer, or novel combinations of colour and figure for the cabinetmaker; fibres of a special character; seeds producing new descriptions of oils; leaves, roots, &c., of unknown medicinal power. In fact, the world has revived once more the art of the alchemist, the attempt to transmute baser materials into more precious ones; and no discovery ever made by the old chemists equalled or even approached the results which have been obtained from substances considered for ages as "waste." It is, however, only within the present century that we are seriously applying the example which nature has been teaching us ever since the first seed-time and harvest, and we have yet much to learn. There is no waste in nature; decay is but a name for the life of new and often beautiful creations. Death begins life, as well as ends it, and no agencies in nature are suffered to waste. The changes which organic life undergoes are but the links leading from one organism to another, and in this transmutation there is no waste, no loss, but perfect harmony of arrangement, by which the life ending in death becomes the death merging into a new existence.

We purpose considering the subject of Waste, and afterwards inquiring into Undeveloped substances. As refuse materials, Mr. Simmonds enumerates a very interesting and lengthy list of articles, which, becoming waste, are by various manipulations changed into new and frequently very re-

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* *Waste Products and Undeveloped Substances.* By P. L. SIMMONDS, Hardwicke. 1862.

markable products. Rags take a very prominent place in the catalogue, and really there is no material which contributes more largely to the transformation scenes of commerce than the cast-off clothing of humanity. By a variety of processes, the rags thrown away by the poorest beggar reappear in the clothing of the sailor, the labourer, or even of the gentleman; or, after passing through the sad history of St. Giles, are met with, tinted *couleur de rose*, in a lady's boudoir in St. James's. Few people not engaged in it are aware of the value and importance of the rag trade. Mr. Simmonds estimates that cotton and linen rags, to the amount of above £300,000, are imported annually, and that "the whole quantity used in the kingdom exceeds £1,000,000." Rags are imported from the various countries of Europe, from the northern part of Africa, from India, and from Australia, America consuming more than her own population can supply.* Linen and cotton rags are used in the manufacture of paper; woollen are converted into shoddy and mungo. An extract from an article on Yorkshire in the *Westminster Review*, quoted by Mr. Simmonds, gives an excellent definition of shoddy,† and an interesting list of its applications is added. It is estimated that the value of shoddy and mungo amounts to above £700,000 annually.

Shoddy is another name for rag-wool, and it was probably first used for purposes of manufacture about 1813; but machines for reducing woollen rags to small particles appear to have been known in London before they were employed in Yorkshire. The shoddy trade is a large one on the Continent. At Berlin several establishments have been formed by Batley manufacturers for making rag-wool. Prussia levies a heavy export-duty on rags, but none on shoddy; hence we receive about 8,000 tons annually, *viâ* Hull, from Prussia, Denmark, &c. In the collection of products from Denmark in the International Exhibition, an interesting series of samples of shoddy were shown. It is estimated that this trade employs 600 persons in Batley alone.

Old woollen rags also form an important feature in the manufacture of prussiate of potash, a chemical largely used in blue colours, in making Prussian-blue, and also cyanide of potassium, which is employed in electro-plating with gold and silver. Woollen rags are also used as a manure in the Kentish hop-gardens, 2½ lb. being considered equal to 100 lb. of farm-yard manure. The agriculturalists of Italy have long been in the habit of planting old woollen garments at the roots of their orange-trees.

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* The perusal of this notice of Mr. Simmonds's book induced us to look at a "Foreign Rag Circular," published by a Liverpool firm, and we there found that, during the month of November last, 11,000 bales of rags (representing about £35,000), were exported from Liverpool and London to New York. These rags had been imported into England chiefly from Egypt, India, and Japan! This circular quoted the prices of about fifty different varieties of foreign rags, varying in value from nine shillings to forty shillings per hundred-weight, imported from Egypt, Japan, Bombay, Beyrout, Hamburg, Palermo, Leghorn, Trieste, Smyrna, Spain, and Valparaiso. There are many other places from which rags are imported. —Ed.

† P. 302.

The cotton-wads, with which engineers clean their machinery, are afterwards worked up into some descriptions of shoddy. Cotton-waste, "the refuse cotton of the mills," is another article of considerable importance, it being manufactured into writing and printing paper; whilst in America it is made into an imitation of papier mâché.

Oakum made from old ropes, again, is the product of a waste substance. Mr. Simmonds states that 1,400 tons, valued at £28,000, are sold annually in Liverpool. The total imports of codilla or tow (the waste fibres which occur in the cleansing of hemp and flax), amounted in 1857 to 13,000 tons, valued at £373,000. It is manufactured into bags, yarn, &c.

Bones form another waste product, though no longer wasted, and Mr. Simmonds gives a very interesting account of the changes which they undergo. Bones are made into manure as superphosphate of lime, or turned into handles for knives, fans, tooth-brushes, umbrellas; or converted into buttons, children's rattles, &c. They are also largely used in the manufacture of animal charcoal (a very important agent in refining sugar). Bones are boiled for the sake of the gelatine which they contain, and this gelatine is used by dyers, and not unfrequently by cooks; the fatty matter obtained being made into soap. The value of bones imported and collected at home is calculated to amount to £700,000 per annum.

This book contains one of the most interesting biographies, that of a dealer in refuse bread, bread crumbs, crusts, &c., which has ever come under our notice.

We must glance rapidly over the list of waste substances, and refer our readers to the complete and varied information which Mr. Simmonds supplies on each subject.

The saw-dust of various woods is a waste product of importance, and employed for a variety of purposes. The husk of the grape, after the fruit has been crushed, is used in making a weaker wine, and also in the manufacture of vinegar. Oil-cakes, formed from seeds after the oil has been crushed from them, are of great commercial importance.

We must not omit to mention another waste material—the waste paper of the Government offices, which sells annually for £7,000.

Dead dogs in Paris and New York are no longer wasted, they are boiled down, and their fat used in the preparation of kid-gloves. Old horses form a perfect mine of wealth, and Mr. Simmonds gives a very curious list of the purposes to which their "remains" are applied.

The waste products of coal show perhaps the most extraordinary results of chemical researches. Gas-water, formerly allowed to run to waste, is now eagerly bought up. The residual products of coal are very numerous, and amongst them are ammoniacal-water, employed in making sulphate and carbonate of ammonia, sal-ammoniac, and alum; coal-tar, which contains a variety of products; naphtha, employed as a solvent, and for burning purposes; benzol, the basis of the endless shades of mauve, Magenta, roseine, &c. Another product is paraffin-wax, which is made into candles; and another creosote, from which carbolic acid is obtained, largely used as an antiseptic. Carbolic, in combination with nitric, produces picric acid, from which are obtained the beautiful greens and yellows so much in fashion of late.

Undeveloped substances afford a still wider and more important field; for every new and untried product comes, of course, under this denomination. Researches are being constantly made, in order to find substances which may contain qualities similar to those already known, but which may be rare and costly. This inquiry opens a new world in which an endless variety of products offer themselves, first as luxuries, but finally as necessities.

Mr. Simmonds's book is especially interesting on this subject, and many of his suggestions are of easy application.

A great variety of substances have been developed as substitutes for sugar; and we need scarcely refer to the substitutes for cotton. Fibres of every description have been suggested, one of the latest being the delicate fibre of the *Zostera marina;* but all proposed substitutes appear to possess three difficulties—short supply, increased cost of manufacture, and inadequate result. The substitutes for tea are very numerous, and many of them somewhat peculiar. We need not specially refer to sloe-leaves, and Mr. Simmonds gives us the satisfactory assurance, "that the great bulk of the tea imported into this country for the last ten years has been unadulterated." Upwards of ninety-eight different plants have been cultivated in various parts of the world as substitutes for tea.

The products of the *Palmaceæ* have never yet been fully developed. In its fruits, nuts, oils, fibres, sugar, spirit, woods, flour, wax, canes, &c., we have a most wonderful variety; but this family contains materials, the qualities of which are not known. It is only of late years that the kernel of the palm-oil nut, *Elæis Guineensis*, has been crushed for the sake of its oil, and this oil now realizes a higher price than that of the fruit. The kernel of the Cohune-nut, *Attalea Cohune*, produces a most brilliant oil, and a series of experiments have lately been tried with it. The Palms produce many fibres which have not yet been tested. A most beautiful specimen was shown in the Exhibition,—so fine in its character, that it looked like human hair.

Mr. Simmonds draws attention to new edible roots, and mentions a large variety. Amongst others, the root-stocks of the Arrowhead, so common in our streams; the roots of various species of the Arum; the bulbous roots of the Star of Bethlehem. In Germany, the roots of the dandelion are consumed. The pig-nut, *Bunium flexuosum*, is well known in England, and might be made an important article of food. The tubers of a species of *Oxalis* have been imported from Peru, and found equal in quality to the potato; and the *Journal de Chambery*, quoted by Mr. Simmonds, states, that the bitter principle in the dahlia can be removed by boiling, and that the root can be used as a substitute for the potato.

Fibres and their substitutes have a chapter to themselves. The beautiful silk cotton of the West Indies has not been employed for weaving purposes, on account of the want of staple. In America it is used in the manufacture of hats. Very beautiful fibres have been obtained from the leaves of the pine-apple and stems of the banana. The aloe, of Mexico, now supplies a very important material, known as Mexican Fibre, and largely used in making into brushes, imitation horsehair, &c.

The substitutes for rags in the manufacture of paper form a most curious

list, and Mr. Simmonds gives some valuable hints respecting new substances which might be used. We must refer our readers to this chapter for much varied information, and after reading it, one is inclined to ask what vegetable fibre has not been employed in the manufacture of paper. Mr. Simmonds mentions that, as early as 1857, a patent was taken out for obtaining paper pulp from wrack-grass, *Zostera marina*, lately introduced as a substitute for cotton.

With reference to suggestions, we would specially refer to the economic application of sea-weeds, for purposes of manure, manufacture of iodine, acetic acid, muriate of potash, sugar, as food, stiffening for fabrics, &c.? Our space will not allow us to do more that allude to the chapter on the uses of Peat, and also to the article on the Utilization of the Waste of the Fisheries for Manure ; but we would particularly draw attention to this chapter.

The whole work, although full of the most practical business information, is written in a pleasing style, and the circumstances relating to the transformations of refuse often read like a romance, rather than a dry detail of the uses of "waste and undeveloped substances."

A Plain and Easy Account of British Fungi. By M. C. Cooke, Author of "A Manual of Structural Botany," "A Manual of Botanic Terms," &c. Twenty-four coloured Plates. London: Robert Hardwicke.

THE author of this volume is already favourably known as having written a "A Manual of Structural Botany." It is introductory to the more elaborate works of Schleiden, Henfrey, Balfour, Lindley, Hooker, &c.; and we have no hesitation in saying that it is the very best and cheapest manual which can be placed in the hands of a beginner.

Mr. Cooke writes for those whose education and means are limited, and with pre-eminent success. It is really a pleasure to read the manuals which he has published, for they are up to the mark, and so complete as to leave hardly anything to be desired.

This new work on the Fungi appears to be equally valuable with those which he has already printed. It contains descriptions of the esculent fungi, the manner in which they are prepared for the table, how to discriminate the nutritious from the poisonous species, details of the principles of their scientific classification, and a tabular arrangement of orders and genera.

It is very creditable to Mr. Cooke that the drawings in his book are all sketches from nature, made by his own pencil. This shows work, and is more respectable than the too common practice of copying engravings from the authorities in the particular branch of science.

This little book is valuable because, in some respects, it is certainly a good guide-book to a number of edible fungi unknown to the public. Unfortunately, our author has not given us the time of the year when they may be gathered, but has left this to conjecture. If found at all seasons, he ought to have said so; if peculiar to the autumnal

months, the fact ought to have been mentioned at the close of the description. In this respect the book is not "a plain and easy account of British fungi." We are surprised at such an omission. We know that some fungi are peculiar to autumn, and others may be found at all seasons of the year. The author had better mention the time when the fungi are most abundant. It will render his book more available.

Dr. Badham, who has written a work on the esculent fungi of Britain, is quoted by Mr. Cooke as saying:—

"I have this autumn myself witnessed whole hundred-weights of rich wholesome diet rotting under trees; woods teeming with food, and not one hand to gather it; and this, perhaps, in the midst of potato-blight, poverty, and all manner of privations, and public prayers against imminent famine. I have, indeed, grieved when I have considered the straitened condition of the lower orders this year, to see pounds innumerable of extempore beef-steaks growing on our oaks, in the shape of *Fistulina hepatica; Agaricus flavipes*, to pickle, in clusters, under them; puff-balls, which some of our friends have not inaptly compared to sweetbread for the rich delicacy of their unassisted flavour; *Hydna* as good as oysters, which they somewhat resemble in taste; *Agaricus deliciosus*, reminding us of tender lamb-kidney; the beautiful yellow *Chantarelle*, growing by the bushel, and no basket but our own to pick up a few specimens in our way; the sweet nutty *Boletus*, in vain calling himself *edulis*, where there was none to believe him; the dainty *Orcella;* the *Agaricus heterophyllus*, which tastes like the crawfish when grilled; the red and green species of *Agaricus*, to cook in any way, and equally good in all."

We are afraid, after such a development as this, that some of the purchasers of Mr. Cooke's volume will be hurrying off to the woods, expecting to find "tender lamb-kidney," "beef-steak," "grilled crawfish," and "oysters" under the trees, and that they will probably come home disappointed.

The author has, however, carefully drawn and described several of the fungi mentioned in this rather strongly-worded passage,—the extempore beef-steak, *Fistulina hepatica*, and the tender lamb-kidney mushroom, *Agaricus deliciosus*, for example. The latter, according to our author, is now called *Lactarius deliciosus*.

As this book may very possibly fall into the hands of persons who may have occasionally some difficulty in procuring a family beef-steak, we sincerely hope they will be successful in finding the extempore one, *Fistulina hepatica*, which our author has carefully figured, and thus describes:—

"*Fistulina hepatica* (*hepar*, Lat., the liver), from its colour, which resembles that of the liver. This fungus assumes a great variety of forms. In its earliest stages it sometimes looks like a strawberry; when more advanced, it has often the appearance of a tongue. One of its continental local names is *Lingua di Castagna*, which applies to this resemblance. It is a fleshy juicy fungus, with an undivided unstalked pileus, and when cut, presents a bright streaky appearance, not unlike beetroot, and contains a red juice; the porous under-surface is yellowish or flesh-coloured. The trunks of old oaks are very commonly the habitat of this species, which occasionally attains a very large size. When old it becomes rather tough, but in all its stages it affords an excellent gravy, and when young,

if sliced and grilled, would pass for a good beef-steak. Specimens are now and then met with that would furnish four or five men with a good dinner. The liver-colour and streaky interior are sufficient guides whereby to recognize this species under all its protean forms."

We agree with Mr. Cooke, that the fungi are deserving of a far greater share of public attention than they have hitherto received, "as articles of food," and we think that his book is well calculated to incite to their study.

Speaking of the sub-genus *Tricholoma*, our author says:—

"It is extremely probable that this group does not contain a single unwholesome species, and it certainly contains several with very fair esculent properties. The whole of these, and indeed, almost every species except the common mushroom, are characterized by the majority of our countrymen, as 'toadstools.' Let us hope that such names, which were originated and have been perpetuated in ignorance, will soon become extinct."

We are afraid that the author will long have slept beneath the "daisy-sod of Britain" before this state of things will be realized. Nevertheless his book cannot fail to do good. There is truth in its pages, and the knowledge imparted by them is calculated not only to add new dainties to the table of the rich, but to enable the poor to provide nutritious food for their families when other means fail them, at certain seasons of the year.

We have little doubt too, from the accuracy of Mr. Cooke's previous works, that this volume on the British Fungi is a *safe* as well as "plain and easy guide" to these plants. He says that—

"The number of poisonous species has been greatly exaggerated; but of these there are many, and the properties of a few are extremely virulent. We have always imagined it prudent to taste unknown species with caution, since we have learnt that some mycologists, having perhaps more enthusiasm than caution, have, from merely tasting very virulent species, suffered for some time afterwards considerable pain and inconvenience."

In default of general rules, our author recommends no one to experiment on species which are unknown, or which he has not pointed out as safe.

"It is not advisable to venture upon such as have a decidedly acrid taste in the raw state, unless they are known to be edible. One or two species which possess such properties when uncooked, are wholesome when dressed; but there are exceptions to the general rule. If only such species are employed as we have described in the foregoing pages, and delineated in the plates, there is no fear of unpleasant results."

The author thus writes about his cookery of the *Lycoperdon giganteum*:—

"A gardener brought us a large puff-ball, equal in size to a half-quartern loaf, and which was still in its young and pulpy state, of a beautiful creamy whiteness when cut. It had been found developing itself in a garden at Highgate, and to the finder its virtues were unknown. We had this specimen cut in slices, about half an inch in thickness, the outer skin peeled off, and each slice dipped in an egg which had been beaten up, then sprinkled with bread-crumbs, and fried in butter with

salt and pepper. The result was exceedingly satisfactory; and finding this immense fungus more than our family could consume whilst it remained fresh, we invited our friends to partake, and they were as delighted as ourselves with the new breakfast relish, to them and to us—the first, but we hope not the last experiment upon a fried puff-ball."

Mr. Cooke employs such excellent material, that we are not surprised that he can make a good dish out of a puff-ball. His skill reminds us of French cookery, which is so celebrated for its metamorphosis into excellent eating of what to an Englishman would be exceedingly unpalatable.

Allowing for a certain amount of enthusiasm so pardonable in Mr. Cooke as a naturalist, we cheerfully commend the book to public favour, as probably containing much that is true, and we think that money may be saved and no person's health endangered by its purchase, careful perusal, and a trial of its numerous suggestions.

The Microscope and its Revelations. By W. B. Carpenter, M.D., F.R.S., &c. Third Edition. Churchill.

THIS new edition of Dr. Carpenter's work contains an account of the most recent researches of microscopical writers and observers, and although it is many years since the first edition was published, this still remains the best text-book of microscopical science extant, and (together with Mr. Van Voorst's Micrographic Dictionary) forms the best existing guide for all classes of students.

SCIENTIFIC SUMMARY.

QUARTERLY RETROSPECT.

ASTRONOMY.

DURING the long nights of the winter months, the telescopic observer is much busier than at other seasons of the year; and although the present quarter has been far from favourable, yet a few discoveries have been made which are somewhat important. M. D'Arrest has inaugurated the erection of a large Munich refractor, at Copenhagen, by the discovery of the seventy-sixth individual of the group of planets revolving round the sun between Mars and Jupiter. His successor at the Leipzic Observatory—M. Bruhns—has signally distinguished himself as the discoverer of *two* comets within a few hours of each other, and thus proved that this branch of astronomy is equally safe in his hands as in those of M. D'Arrest, so famous for his successful search after those bodies. In this, however, M. Bruhns is only following up his previous well-earned renown at the Berlin Observatory, where he detected many comets. By the public in general those discoveries are looked upon as the result of chance; but this is far from being the case, the search being as systematic as any that can possibly take place under the circumstances. Previous to finding either a planet or comet, the sky has to be sounded, surveyed and triangulated with the greatest accuracy—variable stars and nebulæ avoided, and marked with as great care as the rocks and breakers of the ocean—and the result has been that within the last ten years the maps of the smaller telescopic stars are far more correct than those which are visible to the naked eye. It would appear probable that the list of planets is now nearly full,—the perfection of the star-maps does not seem to have any effect in adding to their number, although it is by this perfection that any loose straggler is in momentary danger of being detected. Of late years, those planetary "nuggets" have been found few and far between, contrasting strongly with the rich harvest gathered some years since by MM. Hind, Goldschmidt, and Gasparis. In regard to comets the case is otherwise, and we may always expect an average annual supply of those bodies. In consequence of cloudy weather and moonlight, neither of the new comets has been favourably seen in this country, so that we must defer any further notice of them for the present.

Daphne.—The planet Daphne has been searched for during the last three or four years with great anxiety, but no tidings heard of it until the last few months, when Dr. Luther detected an object of the eleventh magnitude

(on August 31), which turned out to be the missing planet. During the search instituted for it, another planet (the 56th of the asteroids) was detected, which received the name of *Pseudo*-Daphne. This asteroid has, therefore, the distinguished honour of being No. 41, No. 56, and No. 75, of the group of asteroids, two of which numerals it must now be contented to relinquish. From observations on August 31, September 5, and September 11, there can be no doubt of its identity with the original object. Pseudo-Daphne has received the name of *Melete;* the planets 73 and 74 discovered on April 7 and August 29 respectively, being called *Clytia* and *Galatea.*

Lunar Mountains.—Mr. Birt has detected a remarkable chain of lunar craters which have been overlooked by Mädler and Schröter, and whose positions are not given in any other maps of the moon. They are situated on the surface of the Mare Tranquillitatis, being the highest portion of the wall between Menelaus to a point opposite Plinius, and situated on the southern border of the Mare Serenitatis. It is very seldom that they can be advantageously seen, and Mr. Birt was only able to observe them in 1861, April 16, and 1862, May 5 and October 29. On May 5, 1862, he noticed that there were three deep craters, hardly distinguishable from each other, being quite in shadow; two rocks and another crater, which is isolated from the further continuation of this wall, were also seen, they being all situated at the end of the promontory called Acherusia. Mr. Birt has recognized other discrepancies in Beer and Mädler's maps, but does not consider them to be real changes, the great difficulty of seeing them fully accounting for their omission.

The Elchies Telescope.—The great equatorial of Ross, furnished with a telescope of eleven inches aperture and sixteen feet of focal length, has been almost lost sight of since its appearance at the Exhibition of 1851. It has of late years been in the possession of J. W. Grant, Esq., of Elchies, Morayshire, who, however, has been unable to make as much use of it as he could wish, or as his former success with a five-foot telescope in India would lead one to anticipate—he having with the latter instrument discovered the companion to Antares two years before Professor Mitchell, who was furnished with the great Cincinnati refractor.

Professor Smyth, who examined the optical and mechanical arrangements of the Elchies telescope, reports highly on both qualities. When it is considered that one portion of the stand alone weighs eleven tons, its firmness and absence from tremor may be imagined. In the double star 28 Aquilæ, Professor Smyth detected a new or third companion, which is an exceedingly faint object, at nearly the same distance from the large star as the other one. In the triple star Delta Aquilæ, the closer companion was identified, but it was found that it had decreased in brilliancy, from the twelfth magnitude in 1833, to the sixteenth in 1862. Two new stars of the fifteenth magnitude were detected at 61 and 107 seconds from the principal star in the beautiful system of Beta Cygni. A faint companion of the same magnitude was discovered within 70 seconds of Zeta Sagittæ. New stars were also detected in the neighbourhood of 452 Cygni and 1 Pegasi, at the respective distances of 98 and 80 seconds from the principal star, and three new ones were found to accompany 312 Pegasi, at the distances of 81, 106, and 127 seconds respectively. In the

star 222 Arietis, great changes have taken place since 1834,—the principal star of the sixth magnitude, and visible to the naked eye, having vanished completely; whilst the three others, which in 1834 were of the fifteenth, tenth, and ninth magnitudes respectively, when viewed through the Elchies telescope, were found to be two of the twelfth, and the last of seven and a half magnitudes. This may serve as an example of the continual and usually unnoticed changes which are taking place in the heavens. As a crucial experiment of the defining power of the telescope, it may be stated that the blue star of Gamma Andromedæ was completely and more than separated. Scarcely more than half a dozen of the best instruments in the world at the present time would be able to effect this separation.

Great Comet of 1861.—The Rev. Mr. Webb has recently given the result of his observations on the comet of 1861, in regard to the nucleus, envelopes, the luminous sector or fan, the coma, and the tail. The envelopes were the most remarkable portion of the comet, particularly on the night of June 30, when the effect produced was compared to a number of light, hazy clouds, floating around a miniature full moon, and when portions of six of various lengths and degrees of curvature could be distinctly traced. From a general *résumé* of his observations made up to July 23, Mr. Webb is of opinion that as no phase was visible in the nucleus, that this part "either contained no concentration of opaque matter or shone by intrinsic light." The axial rotation of the nucleus also seems improbable, but it would appear probable that there was some amount of libration if we were to judge by the swinging motion of the sector. The latter was of later date than the envelopes and much posterior to the perihelion passage; as the comet retreated from the sun, the envelopes descended on the nucleus, and caused perhaps the increasing apparent density of the whole coma. No indications of rotation were perceived in the tail. The angle which the sector and envelopes made with the axis of the tail would lead one to suppose that a stronger repulsion or a less resisted emissive force acted in one direction from the nucleus than in the opposite. The nebulous veils were always seen better on one side than on the other, but from the position of the comet in its orbit no satisfactory deductions can be made in this respect.

According to wishes expressed by correspondents, we append the elements of the first and second comets of this year.—The first, discovered by M. Schmidt, at Athens, on July 2, near the stars Beta, Rho, and Sigma Cassiopeiæ, was at its shortest distance from the sun on June 22, 5· 43, Greenwich mean time. The longitudes of node and perihelion were respectively 324° 30′ and 298° 35′. The inclination was 8° 14′, the motion retrograde, and the logarithm of least distance 9·992. The second comet of 1862 passed its perihelion on August 23, 7·1 Berlin mean time, the longitudes of node and perihelion being 137° 5′ and 344° 16½′, the inclination of orbit 66° 3′; motion retrograde, and the logarithm of least distance being 9·985.

Companion to Procyon.—The existence of dark stars in the heavens, which controlled the motions of those visible to the eye, which idea is due to Bessel, was good-humouredly ridiculed by Humboldt in his correspondence with the former. It is now, however, made a matter of

calculation, in at least two stars, Sirius and Procyon. In respect to the former star, Peters in 1851 found that the irregularities in its position could be explained by the motion of the bright star about an invisible one, the latter being in uniform motion.

In respect to Procyon, Bessel's hypothesis has also been confirmed, and a binary system in which Procyon moves about a dark star in an orbit whose plane is that of the visible heavens, the distance between the components being about a second and a quarter. The actual distance of Procyon from the Sun being approximately known, M. Auwers concludes that the mass of the dark body is about one-half of that of the Sun, and in any case the mass of the dark body must be at least a hundred times as great as that of Jupiter. If Procyon and its companion have equal masses, that of each would be greater than $\frac{37}{100}$ths of the Sun; and if the mass of Procyon is equal to that of the Sun, that of its companion must be greater than $9\frac{6}{10}$ths that of the Sun.

Mars.—By observations made at the Oxford Observatory between September 18 and October 26 of the present year, Mr. Main has determined the ratio of the polar to the equatorial diameters of Mars as 38 to 39, being almost exactly the same as found by Arago, and which has been so much doubted. On September 30, the ellipticity was found as 245 to 244, and on October 17, as 29 to 28, which are the extremes. For the equatorial diameter at the unit of the distance, Mr. Main finds 9″·38, giving a real diameter to the planet of 4,332 miles.

Comet II. of 1862.—This comet was observed at Hobart Town until September 21, with the naked eye, at which time, of course, it was not at all visible in the north of Europe. Mr. Knott found variations in the position of the luminous sector to the extent of more than fifty degrees.

Star-Cluster in the Southern Cross.—This object, described by Sir John Herschel as resembling a splendid piece of jewellery (the stars in it being compared, from their various and beautiful tints, to sapphires, rubies, topaz, and emeralds), appears to have greatly altered of late years: one has changed, according to the careful observations of Mr. Abbott, from greenish-white to bluish-purple; another from green to pale cobalt; another from green to ultramarine, &c. The colour of stars is, however, so variously judged by different eyes, that probably the above discrepancies are due more to different estimations than any real change.

Suspected Variable Star.—In searching for one of Herschel's triple stars, which could not be recognized as such by Struve, with the great Dorpat telescope, Mr. Dawes immediately perceived the looked-for companion, which was equally unseen by South, Sir John Herschel, and Smyth. From the fact of its being invisible for eighty years in powerful instruments and well-trained observers, and seen in the present year with a telescope of four inches aperture, Mr. Dawes thinks it desirable that it should be put down upon the list of suspected variables. The position of this object is R.A., 19h. 29m.; N.P.D., 100° 32′; the magnitudes, according to Mr. Dawes, $6\frac{1}{2}$, 8, and $11\frac{1}{4}$.

Large Meteor.—A huge *bolide* made its appearance on November 27, which was visible in all parts of the British Islands and France. As seen by the writer, it appeared as a huge globe of fire of a balloon shape, almost

if not quite as large as the Moon, though in other respects bearing no resemblance to that body, being of a hazy contour, emitting a dazzling blue light at first, which became afterwards of a yellowish tint. Although visible for only a few seconds, no person in the open air at the time could fail to notice it as it came out of the sky with the quickness of a flash of lightning, and disappeared equally suddenly, its course being in the direction from Mars to the Moon. We hope in our next to be able to give some account of its track and height.

The *Comptes Rendus*, November 17, contain a letter from P. Secchi to M. Elie de Beaumont, concerning the planet Mars, in which the former states, that there can be no doubt that the white polar blotches on that planet are masses of snow, or of clouds condensed at the poles; that the persistence of the blue channels show them to be seas, and the red patches continents.

The comet first discovered by M. Bruhns will be visible in those latitudes during the month of January. On January 1, 1863, it will be close to the star Kappa Coronæ (of 4½ mag.), and not far distant from the star Zeta (of 4th mag.). It travels after this to the constellation of Vulpecula, and is close to Flamsteed 25 on January 28 (of 6th mag.). It is at its greatest brilliancy on January 1.

The second comet has disappeared at present, but may probably be visible at the end of February. It likewise is at its greatest brilliancy on January 1. On February 17, it is in the constellation of Cetus.

BOTANY.

Artificial Formation of Cork. — M. Casimir de Candolle, the third of that name, describes the mode by which, in Algeria, superior cork is obtained from the cork oak. The rough corky layer is removed down to the subjacent cellular envelope, or green layer, during summer and autumn. In consequence of this removal a new corky stratum forms upon the green layer at a variable distance from its denuded surface. This stratum grows in annual layers upon its internal surface, just as the original worthless corky layer did; but it is much finer, and more elastic. After seven or eight years it is sufficiently grown to be removed, and the same process is repeated. This may be done many times, and new cork removed every seven years to an almost indefinite extent.

The Exhalation of Ozone by Plants.—In the *Comptes Rendus*, M. Kosman details experiments from which he deduces these results: That plants disengage ozonised oxygen from their green parts, during the day, in greater ponderable quantity than exists in air. During the night the same thing takes place, if accumulated masses of vegetation are in vigorous growth. Town plants disengage less ozone during the day than country plants; hence the air of the country is more *vivifiant*. In the midst of the town there is more ozone in the air at night than during the day. The corollas, or coloured parts of the flower, do not disengage ozonised oxygen; and, lastly, in inhabited rooms, oxygen does not generally exist in an ozonised state.

Hybrid Plants returning to their Original Species.—M. Naudin, having fertilized plants of Datura stramonium with others of D. Tatula, afterwards sowed the seeds produced by this union, and obtained hybrids of the first generation. These hybrids were isolated; and a few seeds coming to maturity, they were sown in April, 1862, and produced twenty-two plants of the second generation, viz., five of Datura stramonium in all its purity, whose fruits ripened and came to maturity; and nine typical plants of Datura tatula. The remainder were more or less of a hybrid character. M. Naudin believes that this third generation of the hybrids will turn completely to D. tatula. These remarkable facts, which demonstrate the fact of the spontaneous disappearance of fertile hybrids, without the intervention of a crossing with one or other of the parent species, appear to M. Naudin at present inexplicable.

Acclimatisation of Japanese Plants.—M. Simon, writing from Japan, continues to recommend valuable plants for introduction into the *Jardin d'Acclimatisation*. The hemp palm (*Chamærops excelsa*) bears a temperature of 10° Fahrenheit, requiring no particular care. The stalk of each leaf is covered with filaments of various fineness, of which the coarsest are used for ropes, and the finer for nets. Another plant he speaks of is the *soja*, a kind of bean used by the Japanese for a condiment, and a very savoury adjunct to almost every Japanese dish.

The Sago Palm.—Mr. Wallace, who has returned, laden with valuable information, from his Eastern travels, speaks of the sago palm as the staff of life to the inhabitants of New Guinea and the adjacent islands. He described it as a truly extraordinary sight to behold a whole tree trunk converted into human food, with as little labour as is required to convert corn into bread. A single good tree will produce six hundred pounds of sago cakes; and with an expenditure of ten days' labour, a man may produce food sufficient for a year's consumption. The natural result is improvidence, laziness, degradation, and misery.

Botany of North Yorkshire.—Local floras and local faunas being of great value and importance, we gladly notice the preparation of a work to include the flora of this interesting part of England. North Yorkshire stands midway between the North and South of Britain, and can claim for its own about three in four British species. About 1,600 species of flowering plants, ferns, and mosses will be described; and as a valuable adjunct, sets of the rare and critical plants of the district are prepared, containing each about one hundred specimens.

The Cotton Substitute.—The substance proposed by Mr. Harben, and spoken of in our last as favourably mentioned as a substitute for cotton, has now long been known to be the fibre obtained from the Grass Wrack (*Zostera marina*). The subject has since that time been before the public, and well canvassed by practical men. The result, at present, appears to be that, although it may prove useful as a supplement to cotton, or for mixing with other fabrics, neither the nature of the fibre, nor the source of its supply, renders it probable that it can make us independent of the cotton-plant.

The Potato Disease.—Dr. de Bary, of Freibourg, has recently published a pamphlet containing an epitome of all that is known regarding the potato disease, and gives the results of his observations. He finds the theory of its being due to a parasitical growth to be correct. A seed or spore of the parasite, when placed in the leaf, he says, will penetrate the tissue in twelve hours, and in sixteen hours it bursts through the leaf, and is ready to reproduce itself at the rate of 19,620 zoospores for every square line of its surface.

CHEMISTRY.

PURE CHEMISTRY.—Among the various matters of scientific interest, we may notice the experiments of M. Robinet, with reference to the purity of ice. It appears that water is rendered almost as pure by congelation as by distillation; the calcareous and magnesian salts being forced out, in the act of freezing, as completely as the more soluble salts. He states that frozen water may be used for most chemical purposes in place of distilled water. Dr. Rüdorff has found that when a saline solution has frozen to such an extent that there is not sufficient water remaining to hold the salt in solution, it crystallizes.

A new method of preparing hyposulphuric acid has been described by Gelis; it consists in acting on sulphurous acid with hydrated peroxide of iron; the peroxide is suspended in water and sulphurous acid-gas passed into the solution where a compound of sulphurous acid and peroxide of iron is formed, which decomposes in a short time into hyposulphate and sulphite of protoxide of iron.

Mendius has found that when the nitrites are exposed to nascent hydrogen, a transformation takes place, and an amine base of the next higher homologous alcohol formed; the method of proceeding was to act on a mixture of the nitrite with sulphuric acid by metallic zincs; by this method hydrocyanic acid, acetonitrile, butyolonitrile, and benzonitrile, were transformed into methylamine, ethylamine, amylamine, and a new base of the composition, C_7H_9N.

The conversion of aldehyd into alcohol by means of nascent hydrogen has been accomplished by Wurtz. To effect the change, all that is necessary is to expose a dilute solution of aldehyd in water to the action of an amalgam of sodium, when part of the aldehyd becomes resinified and the other part combines with hydrogen, to form a body possessing all the properties of ordinary alcohol.

This process of transformation of organic bodies by the introduction of nascent hydrogen seems to be of general application, for Linneman has changed sugar into mannite, by acting with sodium amalgam on cane sugar, which has been changed to grape sugar by sulphuric acid; and benzoic and valerianic aldehyds have been converted by Friedel into benzoic and valerianic alcohols.

Mr. J. J. André has lately studied the action of chromic acid on vegetable alkaloids. He has found that definite crystallizable compounds

can be prepared, but that great care is requisite to prevent a reduction of the chromic acid taking place; quinine and brucine combine in two proportions with chromic acid, but cinchonine, quinidine, and strychnine form only one compound, for on adding a solution of neutral chromate of potash to a solution of a salt of one of these bases, a portion of the base was precipitated from the solution, and the neutral chromate of the base was found in the filtrate.

The formation of organic compounds by synthesis is highly interesting, inasmuch as it is a great onward step to the investigation of the processes by which these bodies are naturally formed. The number of such transformations is rapidly increasing, and no doubt eventually some light will be thrown on the changes that occur during the growth of animals and vegetables, and the formation of the complex and varied organic bodies found in their different parts. The formation of acetylene by the passage of an electric spark between two charcoal points, placed in an atmosphere of hydrogen, is of great interest, inasmuch as it is formed by the synthesis of its elements without the pre-existence of an organic body; and starting from this substance a whole series of organic bodies may be formed by further synthesis, as has been shown by Berthelot, who made the discovery of the synthesis of acetylene.

An interesting communication by Mr. E. Dancer has been read before the Chemical Society, "On Hypobromous Acid," in which the author has demonstrated, by most conclusive experiments, the chemical properties of this body. He did not succeed in preparing hypobromous anhydride, but found that the hydrated acid could be produced by the action of bromine water upon the red oxide of mercury, similarly to hypochlorous acid, to which it had a great analogy, possessing also powerful bleaching properties. This body was also formed by the action of bromine upon nitrate of silver, as had been previously shown by Mr. Spiller. It was impossible to prepare a more concentrated solution than that containing six per cent.: partial decomposition ensued on distillation at ordinary pressures, but by the aid of the air-pump this could be prevented. With dilute solutions of the caustic alkalies, bromine gave rise to the production of bleaching solutions, containing soluble hypobromites, but with concentrated solutions bromates and bromides were formed.

The General Medical Council, after some deliberation, have resolved to leave the grain weight unaltered, and to retain the avoirdupois pound and ounce, but to discontinue the use of the drachm and scruple in the Pharmacopœia. The confusion occasioned by the introduction of new weights, and the difficulty of adapting old formulæ to a new system, are objections to a change in the standard weights; but considering the numbers of different systems of weights and measures now existing, the introduction of a decimal notation would afford an immense simplification, and possibly prevent many mistakes.

Dr. Sheridan Muspratt has recently made analyses of the waters of the mineral springs of Scarborough, from which it would appear that there has been some mistake as to the comparative medicinal properties of the north and south springs, the north spring being richer in magnesian salts, but containing less iron than the south.

The results of the analysis are expressed in the following tables:—

	North. Cubic inches.	South. Cubic inches.
Nitrogen	7·4864 ...	7·9792
Carbonic acid	43·3112 ...	38·0408

Mean temperature of the water, 48°

	Grains.	Grains.
Carbonate of lime	42·354 ...	34·846
Carbonate of magnesia	2·844 ...	3·051
Carbonate of iron	1·465 ...	1·996
Carbonate of manganese	trace ...	trace
Sulphate of magnesia	98·952 ...	90·992
Sulphate of lime	69·120 ...	69·537
Sulphate of soda	7·060 ...	2·015
Chloride of sodium	19·287 ...	19·540
Chloride of potassium	3·002 ...	2·416
Chloride of magnesium	1·941 ...	0·920
Silicic acid	0·859 ...	1·063
Organic matter, &c.	traces ...	traces
	246·884	226·376
Sp. gr. of the water	1·0033069	1·0028378

A process for the preparation of silicated hydrogen in considerable quantities has lately been brought into notice. Dr. Martius has been engaged in making metallic magnesium by reduction of the chloride with sodium; for this purpose he employed an earthen crucible, and on examining the product he found that it contained silicium, and gave off inflammable gas during solution in hydrochloric acid. By introducing larger quantities of silicium he was able to prepare the gas in a state of greater purity; it possesses, like phosphoretted hydrogen, the singular property of spontaneous inflammability.

It is generally stated, in books on chemistry, that camphor has a tendency to deposit towards the light, by which it is meant, that if a bottle containing camphor be exposed to sunlight, the camphor will be deposited in crystals on that part of the bottle which is turned towards the light. Mr. C. Tomlinson's experiments however have led him to the conclusion that heat, not light, is the cause of the phenomena observed. He exposed a great number of bottles of camphor to light under different circumstances (for instance, when immersed in water), and found that no deposit was formed under those conditions that prevented a radiation of heat.

II. Applied Chemistry.—A patent has been recently taken out by Mr. James Webster, for a process for making oxygen gas from nitrate of soda, and at the same time obtaining certain other valuable products. The process consists in heating a mixture of the nitrate with oxide of zinc in retorts; the nitric acid is decomposed by the heat into oxygen and nitrogen, the soda remaining behind, is separated by water from the oxide of zinc. It is proposed to employ the oxygen in metallurgical operations, and for

the production of light; the soda will be very valuable in soap-making, and for many other purposes to which this substance is applied.

A new method of preparing iodine from seaweeds has been suggested by Mr. M'Ardle; it consists in fermenting the plants in water until the organic matter is destroyed, when the inorganic salts will be left behind; a considerable saving is effected by this process, for in the old method of burning the seaweeds some of the iodides are volatilized and lost.

The American oil-wells still continue to furnish large quantities of petroleum, which has become an important article of commerce. It has been proposed to employ it in the manufacture of illuminating gas. Experiments have been made for the purpose of ascertaining the amount of gas furnished by the destructive distillation, the oil being allowed to fall into a heated retort, together with a little water. The result was satisfactory. A great advantage in the gas prepared in this manner over coal-gas would be, that it would be free from sulphur compounds, and would not require so much purification.

Although a great many processes for rendering textile fabrics fire-proof have been proposed, a really good method for accomplishing this end is still a desideratum: it is rather difficult to find a substance that answers the purpose completely, is cheap, and does not injure the fabric in any manner. It is not necessary to render the material altogether incombustible; but only that it should be difficult to inflame, and that, when removed from the fire, it should either cease to burn, or at least should only smoulder. When it is remembered that ladies lose their lives at the rate of 750 per annum for the sake of their skirts, the importance of the subject will readily be admitted.

Until quite recently, methylated spirit was supposed to be undrinkable; a careful investigation having been made by eminent chemists for the purpose of ascertaining whether or not it could be rendered potable by chemical processes, the answer seemed to be decidedly in the negative, at least with respect to any wholesale purification of the article. This has, however, been accomplished by Mr. Eschwage. He simply passes the liquid through a succession of charcoal filters, which remove the unpleasant smell and taste. The only part of the process which is claimed in the patent is the management of the filters, which are so arranged, that when the first becomes exhausted it is removed and replaced by the next in order, and the new filter made the last in the series, so that each filter is worked until it is completely exhausted. The peculiar flavour of the methylic spirit is almost perfectly removed by this treatment, so that it could be employed without detriment for medicines, &c. Some druggists, however, seem to have no scruples in employing the impure and disagreeable liquid in the manufacture of medicinal tinctures. The consequences of this are most unpleasant, both to the patient who has the misfortune to take the medicine, and to the physician who prescribes it. Draughts, intended to stop sickness, and quiet the stomach, have quite the opposite effect, and dangerous results ensue.

So little of the unpleasant taste and odour of the methylic spirit remains after the charcoal treatment, that the addition of any flavouring material completely conceals it; and as the apparatus, once fitted up, involves no

great expense, it becomes a question whether the addition of wood spirit to alcohol will any longer prevent its being employed in the manufacture of spirituous drinks, so that the ultimate result would seem to be disadvantageous rather than otherwise, for it will put a stop to the sale of methylated spirit, free of duty, for the manufacture of varnish and other commercial purposes.

M. Regnault has described a method of recording the temperature and pressure in balloon ascents, without observation of the aëronaut. The apparatus consists of a series of tubular reservoirs, with capillary tubes proceeding from them; at the end of each capillary tube a larger tube, filled with chloride of calcium is fixed, so that only dry air can enter the reservoir. These constitute the thermometric system. The barometric consists of a similar series, with their reservoirs immersed in melting ice. In order to insure the temperature of the ice remaining constant in the extreme cold of the upper regions, it is recommended to surround the vessel containing the ice with another vessel containing warm water at starting. The tubes are numbered to correspond in each series. To determine the temperature and pressure at any moment, it is necessary to close the stop-cocks of one tube in each series simultaneously, the balloon not being in rapid motion at the time. The density of the air contained in the tubes is afterwards determined, from which both the temperature and pressure at the time of closing can be deduced.

GEOLOGY AND PALÆONTOLOGY.

A YEAR or two ago no geological doctrine was believed to be better demonstrated than that which declares granite to be a fire-formed rock. The generalization agreed well with the theory known as Laplace's —really Sir W. Herschel's—of the consolidation and cooling of the earth from a fiery state, which most mathematicians and geologists accept; and was submitted to such complete discussion in the famous war of Wernerians and Huttonians, that the possibility of the idea being imperfect or wrong was never suspected. In the days of its adoption, however, and indeed till recently, the earth's crust was regarded as a mere egg-shell of some ten miles thickness, which any Plutonic disturbance might pierce; but latterly the central fluid mass has been placed at greater and greater depths, till now there is probably no one who regards it as likely that fluid rock is forced up to the surface of the earth from its centre. Then came the researches of Mr. Sorby on the microscopic structure of igneous and intrusive rocks; and, as is well-known, the occurrence of cavities containing water and a bubble of air, in their constituent crystals, led him to conclude that the temperature at which granite was produced could not have been excessively high, and that water in a heated state was not absent from it when formed. And now Professor Harkness has added further to the evidence, and drawn a most important conclusion, destined we believe to be generally adopted. Whilst examining metamorphic strata in the highlands of Scotland, he has found that the *strike* of the Plutonic masses corresponds with that of the metamorphic rocks, and accordingly infers

that in that district at least, Plutonic masses do not perform the office of axes in elevations. The general idea is that the granitic rocks pushing up from below have bent up the over-lying stratified beds like the thatch on a hayrick; but this view received a rude shock some time since, when Mr. Selwyn discovered, in Victoria, granitic masses which pierce old strata without affecting their dip, the dip on one side being coincident with that on the other side. And now, in Sutherland and Banffshire, Mr. Harkness believes the facts to indicate, that the water-formed deposits were upheaved, flexured, and contorted, prior to the period when granites made their appearance in them. And, finally, he tells us in so many words that, as regards its origin, there are "abundant features which would support the conclusion that granite is, in that district, rather the result of an excessive amount of metamorphic action than a Plutonic rock." What these "abundant features" are, it would have been interesting to have learnt; but one that could not have been undervalued is the existence of the metamorphic rock gneiss. Knowing as everyone does that that seeming granitic substance is really an altered sedimentary deposit, it only needs the hint to comprehend that the difference between granite and gneiss is one of degree and not of kind; that these differ much less from each other than does gneiss from a water-formed rock; and, therefore, when all the preceding facts are remembered, it requires no stretch of the faith to lead to the conclusion that similar forces to those which produce metamorphic strata, only operating through longer periods or in greater intensity, may have formed granite. This would account for the correspondence of *strike*, the coincidence of *dip*, the presence of water-globules, and many another otherwise unaccountable circumstance; while it makes no demand on the assistance of deep-seated central forces. It is nowise our function to follow this thesis further, but the reader will probably see that if satisfactorily demonstrated, it will necessitate a new theory of the elevation and depression of land.

The origin of river valleys has long been a moot point. With that pertinacity which always characterizes scientific wars, one school has maintained that rivers erode their own channels, while the other party, triumphantly pointing to instances where streams go out of their way to pass through mountains, has held that they found the general features of their courses ready formed. In this state of our knowledge, or rather ignorance, Mr. Jukes comes forward to solve the riddle. His explanation is extremely startling, but probably in its general features true. Before giving an analysis, however, it will be but fair to say that, in our judgment, the new doctrine is not yet fully proved; and that the essay in question, though philosophically conceived, and written with clearness, errs in sometimes regarding complex and debateable theories as axioms.

The district selected for typical illustration is the South of Ireland, the central plain of which is carboniferous limestone, some 300 feet high. And to the south of it are several ranges of hills, some made of the subjacent old red sandstone and Cambro-Silurian, others of the superimposed Coal rocks, and it is from these that the streams to be mentioned rise.

In the case of every river examined, including the Shannon, Blackwater,

Lee, and many others, it becomes evident that they could not possibly have excavated their valleys since the limestone attained its present low level; for, in every case, after draining the upper part of a valley, the river, instead of following its natural and shortest course over the lowest land to the sea, turns aside to cut through high bluffs of old red sandstone or older strata; and if these deep channels were dammed up to the height of 200 or 300 feet, the rivers, instead of toppling over the obstructions, would have taken widely different courses. Yet Mr. Jukes, finding that these ravines are not along lines of faults or fissures, and failing to detect any signs of dislocation, believes that the existing rivers have worn their channels through the hills.

Now, because there are many valleys in the "old red" exhibiting highly inclined carboniferous strata resting conformably on it, the conclusion is legitimately drawn, that the rocks of these parallel latitudinal valleys were once continuous, and have been denuded subsequent to the age when both systems of strata were thrown into great lateral folds. Similarly, because the isolated mountains of coal measures have the same dip and contain the same fossils, it is regarded as demonstrated—not only that the solitary hills were once connected by intervening rock of the same kind, but that the coal deposits once extended continuously over all the limestone. All this vast thickness of several thousand feet has then been removed; and hence the ridges formed by contortion have all been cut off, and the country so far converted into a plain; and it might be easily shown that this denudation could only be accomplished by the sea. Mr. Jukes believes that in all cases where the conntry is flat, and the beds are not horizontal, the open sea, by long continued action over it, has, "like a gigantic planing machine," removed the elevations.

And thus it becomes evident that approximately the land rose up as a flat, over which, from the beginning of the upheaval, the drainage will have flowed from the peaks to the sea. And this necessarily implies that the deep valleys in the old red sandstone containing carboniferous limestone did not then exist, but that the carboniferous and old red rocks were at the same level. And the point of the paper is, that the wasting action of the atmosphere and rain is regarded as the cause which has removed the whole mass of the limestone to a depth of 300 feet, and so formed the valleys. For had these valleys been filled up, the rivers would have taken their present courses over the old red sandstone to the sea; and as the river and atmosphere acting together would necessarily be a more potent power than the atmosphere alone, it is conceived that the rivers would deepen their beds faster than the rate at which the level of the limestone descended. But as these limestone valleys were formed, they produced lateral rivers of their own, flowing to the east, and these were, of course, received as tributaries where they reached the original steam; but from draining a much larger area, the feeder was larger than the river, and now has the appearance of being the river itself.

Such is the theory; and it certainly accounts satisfactorily for the existence of the deep tortuous ravines through which the rivers flow. While there is no difficulty in the thickness of rock removed, except the trifling consideration of the lapse of time it must represent, for in county

Clare, blocks of limestone, which formed part of a bed two or three feet thick, have been wasted by the atmosphere, till all now left to represent them are mere cakes an inch or two thick.

It is believed that this great atmospheric denudation has been going on ever since the carboniferous period; for, excepting the depression during the glacial epoch, Mr. Jukes regards it as certain that the South of Ireland has been dry and high continuously from that time.

Should this explanation be generally accepted, of course it must be applied to the rivers of the Weald, and many in the North of England; while it will at the same time be conceded that all the minor features of the districts are the result of a gradual action on the soluble rocks, like the melting of a jelly-fish in the sun.

The *remains of a large placental mammal* have been detected in the upper greensand by Mr. Harry Seeley.

Preservation of Fossil Shells.—It is well known that shells often consist of two distinct layers; an outer one secreted by the margin of the investing membrane called the mantle, and an inner pearly layer secreted by the whole of the mantle. The pearly layer is composed of the form of carbonate of lime crystallizing prismatically, called aragonite, while the outer layer is often the other, or rhombohedral form, called calcite. And it has for some time been observed empirically, that the shells of the Chalk have all lost their inner layers; while in some other deposits, such as the Portland oolite, Cambridge greensand, &c., multitudes of the fossils have lost the whole of their shells, and exist only as moulds, while some other genera existing with them, and often nearly allied, always have the shell preserved. This has induced Mr. Sorby to make experiments on a large number of recent and fossil shells; and as the result, he finds that when the shell is preserved it is in every case *calcite*. And that shells in the state of aragonite, such as Trigonia, always have a tendency to become crystalline by taking the form of calcite; and if in this change the conditions are more favourable for crystallization in some other place rather than *in situ* the shell disappears altogether.

MECHANICAL SCIENCE.

The Middle Level Drain.—That necessity is the mother of invention is nowhere more frequently illustrated than in engineering practice, and the inundation of Marshland, in consequence of the undermining of the quicksand foundation of the great outfall sluice of the Middle Level drain, has caused the engineer to resort to several novel expedients; one or two of which from their value and ingenuity deserve permanent record. The drainage waters of the Middle Level district are conveyed through Marshland to the Ouse by the Middle Level drain, which had at its termination an outfall sluice with three openings, each twenty feet wide, to permit the discharge of the drainage at low water, and to prevent the reflux of the tide. During March and May last, the bank at the wing-wall of the sluice was undermined, and gave way, admitting the tide to the drain, and,

subsequently, by the failure of its banks, to the Marshland district which has a separate drainage. It is not necessary here to narrate the series of unsuccessful attempts to stay the progress of the flood. In the end, Mr. Hawkshaw succeeded in forming a dam which has kept out the tide by constructing two parallel walls across the drain, consisting of close piles, extended gradually from each side towards the centre where an opening of ninety feet was left. Across this opening twin piles were driven, at distances of about seven feet from pair to pair, and with a space of eight and a half inches between the piles of each pair. In the groove between the twin piles massive panels were dropped at the ebb, when the flood on the lands was at its lowest. The panels were sufficiently strong to prevent the ingress of the tide, until by filling up the space between the two rows of piling with puddle, and dropping barge-loads of chalk and stone against their interior and seaward faces, the temporary dam was converted into an impervious and durable embankment. It now remained to draw off the waters from the flooded land, and to provide for the future exit of the drainage waters of the Middle Level, which otherwise in winter would have endangered the rescued lands as much as the tide had done before. For this purpose, Mr. Hawkshaw has adopted six immense iron syphons, the number of which is to be increased to fifteen. Each syphon consists of a tube three feet six inches in diameter and 150 feet long, which rising from the lowest level on the landward face of the embankment, bend over its crest and dip down to the foot on the seaward face. They have valves at each end which permit the flow of the water from the drain towards the sea whenever the tide has fallen, so that the level of the water in the drain is above that outside; but prevent its reflux on the return of the tide. A ten horse-power steam-engine and air-pumps are employed to exhaust the air from the syphons, both that originally in them and that continually disengaged from the water. About 50,000 gallons of water per minute are said to be discharged by the six syphons already constructed.

Mr. Thorold has suggested the employment in future, in works of this kind, of a duplicate sluice at the back of the sea-sluice, for the purpose of keeping up a head of water, at an intermediate height, between the two sluices, when the sea-sluice is closed by the tide; so that the hydrostatic pressure may be distributed over twice as many supports as hitherto.

Dr. Grimaldi has introduced *a form of boiler*, similar in many respects to the old multitubular, but in which the system of tubes is maintained in slow revolution about the axis of the boiler. The generation of steam is more effective than with fixed heating surfaces, and the boiler space for a given quantity of steam may be reduced one-half. A small engine has been constructed in America, in which the boiler considered as a reservoir of steam is dispensed with. The steam is generated at the instant it is required in a small vessel thirteen inches diameter by thirty inches long, into which the feed water, previously heated by the exhaust steam, is admitted in measured quantities and in the form of spray. This spray impinging on highly heated metallic surfaces, flashes into steam and is superheated. No doubt on this plan some of the sources of danger and waste which exist in ordinary steam-engines are avoided, but a most serious defect is probably

at the same time introduced, one which has hitherto proved fatal to the success of the air, or so called caloric engine ;—viz. : the inefficiency of the furnace.

We discovered, soon after writing our last notice, that one of the *Lenoir motors* was exhibited at South Kensington, and occasionally at work there. It appears to be a perfectly successful application of the force of the explosion of measured volumes of coal gas and air, fired within the cylinder, by the ignition of the poles of a galvanic broken circuit at each end.

Renewed attempts have been made to form an *alloy of nickel and iron*, similar to that found naturally in meteoric iron, which is known to possess great malleability and strength. During the Russian war, Mr. Fairbairn made experiments on various alloys of nickel with cast iron, but without obtaining any increase of strength. More recently, Mr. Longmaid has succeeded in alloying nickel with iron in the puddling furnace, producing a material more nearly resembling meteoric iron than that experimented on by Mr. Fairbairn. The Austrians are said to be using for their cannon an alloy called Aich metal, from the name of the inventor, and composed of copper 600 parts, zinc 382 parts, and iron 18 parts. Its tenacity and toughness are said to be very great.

Guns and Iron-cased Ships still attract the attention of engineers. A new form of rotating projectile, invented by Mr. Woolcombe, was described at the last meeting of the British Association. It is in form a thick zone or circular disc,—in fact, it is cheese-shaped, with the centre of gravity eccentric, or not coinciding with the centre of figure. It is fired from a smooth-bore gun, in which two equal and parallel segments of a cylinder have been inserted, to reduce the bore to the same sectional form as the shot. In consequence of the eccentricity of the centre of gravity, the shot rotates in its flight, in a plane parallel to its faces, and perpendicular to its axis, and this altogether independently of any rifling of the gun. Hence, on the principle exemplified in the gyroscope, the axis about which the shot revolves will remain parallel to its first position throughout its flight, and some of the causes of deviation in ordinary round shot are counteracted.

Renewed *experiments at Shoeburyness*, against a target of massive teak framing, with armour-plating resembling that of the *Warrior* and *Minotaur*, have shown that $4\frac{1}{2}$-inch and $5\frac{1}{2}$-inch wrought-iron plates can be easily penetrated by Mr. Whitworth's steel flat-ended shells, fired from a 120-pounder gun, with charges of from 23 lb. to 25 lb. of powder. The 275 lb. shot from the Horsfall 13-inch smooth-bore gun, with a charge of 75 lb. of powder, was also fired at this target, and smashed through armour-plate, backing, and skin, carrying completely away several superficial feet of the target. The Whitworth shells, on the other hand, made comparatively clean punched holes, which it would not be difficult to plug. The difference of result is mainly due to the difference in diameter of the projectiles, causing fracture with Mr. Whitworth's shells by punching, and with the Horsfall shot in a mode more analogous to cross-fracture. The difference of the charge of powder in the two cases must not, however, be overlooked.

Thus the balance of superiority, which for a short time had rested with the iron-clad vessels, is now undoubtedly reversed, and the guns are

masters of the situation. In considering the influence of these experiments on the future of our navy, it must be borne in mind, that although it will probably be found to be impossible to clothe frigates of the *Warrior* type with a greater thickness of iron than has already been furnished and found vulnerable; yet, by reducing the height above water, the Americans have been enabled to use 7-inch armour-plates, and for the *Ericsson Monitors*, now building, it is said 10½-inch plates are being employed.

The question of the relative advantages and disadvantages of the Whitworth, Armstrong, and other guns, has not been advanced a single step by the recent trials, although it is now in a fair way for settlement. The remarkable results obtained by Mr. Whitworth are almost entirely due to the form and material of his projectile,—a form and material employed previously by others on a small scale, but with similar results.

Some remarkable investigations have been made by Mr. Froude, Professor Rankine, and Mr. Crossland, on *the motion of waves and the rolling of ships.* These are much too abstruse for quotation here, and indeed are, for the most part, of interest only to the scientific shipbuilder and mathematician. We may, however, mention an incidental result of Professor Rankine's, which possesses greater claims to popular notice. The height of waves is a subject on which savans and sailors have long had a dispute; the former affirming that, by actual measurement, they do not exceed twenty to thirty feet from trough to crest, at the maximum; the latter, who, from their long familiarity with the sea, should know of what they speak, maintaining that they constantly rise in storms to a height of a hundred feet, or more. M. Michelet not very long ago asserted, with warmth and sarcasm, that the off-hand scepticism of scientific men on this subject was in exceedingly bad taste, and that the sailors were, in his opinion, in the right. Professor Rankine, however, is able to justify his scepticism. He shows that, in a vessel floating on waves and rolling periodically in consequence of successive impulses, the *apparent direction* and force of gravity undergoes considerable changes. Hence the sensations of a passenger in such a vessel—whose body accompanies the vessel in her movements, and describes, like each particle of water, a circular orbit,—are really the same as if the force of gravity changed in that manner. Such a person judges of the height of the crest, and steepness of the wave front, not according to the real elevation and position of the crest, but according to its perpendicular distance from a plane which seems to be level, but which is really very far from horizontal. The sailor, in fact, measures the wave in a diagonal direction, which his sensations lead him erroneously to believe vertical. "This delusion seems to account," says Professor Rankine, "for the exaggerated descriptions which we hear, of waves 'mountains high,' and which present so strange a contrast to the results of accurate measurement. For example, the waves which Dr. Scoresby measured in the Atlantic Ocean, and found to be about thirty feet high, would seem, when estimated by the eye, under the circumstances just mentioned, to be upwards of ninety feet high, and of terrific steepness. The same delusive judgment as to the height of waves and the direction of gravity accounts also for the appearance, that many have observed, of enormous waves seeming to sink, and as it were melt away, just before

reaching the ship." This is far from being the first time that science has shown the evidence of the senses to be a fallible guide.

Mr. Robert Aytoun has suggested *a new Safety-Break for railway trains* to the Scottish Society of Arts. He proposes to fix to the sleepers, between the rails, a longitudinal stringer of timber, five inches square, to be compressed by a pair of compound bladed springs, of any requisite amount of power affixed beneath the break-van, and under the command of the guard. The plan has some merits, but it is probable that the continuous breaks, already to some extent introduced, afford a readier mode of proportioning the break-power to the heavy trains now run upon railways, and they have the advantage of preventing shock, by distributing the retarding power to all the carriages.

MEDICINE, SURGERY, AND THERAPEUTICS.

MEDICINE.

Graham's Method of Dialysis in Cases of Poisoning.—This method of analysis, invented by the Master of the Mint, is becoming valuable as an aid in the investigation of the contents of the stomach, &c., in cases of poisoning. The chief difficulty, hitherto, has been, that the contents of the stomach are too viscid to pass through any filtering material, and, consequently, the separation of any poison is much impeded. Dialysis here comes in very usefully, and may be thus practised :—A round vessel of glass, open at the top and bottom, is taken : across the opening below is stretched, and firmly tied, a piece of De la Rue's parchment-paper; the vessel is then placed in a dish with sufficient distilled water to reach and cover the parchment; the substances to be dialysed are then introduced into the glass vessel and allowed to stand for twenty-four hours. The membrane will allow substances of crystalline form to pass, but retains those without definite shape, as gum, gelatine, albumen, &c. By this means, the crystalline alkaloids, morphia, strychnia, &c.; numerous metallic salts, as corrosive sublimate, arsenic, and so on, will be found, if originally present with the matters submitted to dialysis, in thin and clear solution, in the containing dish; when, of course, the tests for the identification of the suspected poison can be easily and satisfactorily applied.

Researches on Diabetes.—Dr. Pavy, professor of physiology in Guy's Hospital, has lately published a work on this obscure disease. According to Bernard, a French physiologist, the starchy matters that we take in our food, after being acted on by the saliva, become grape sugar, which is soluble, and is absorbed by the stomach, passing through the liver unchanged, to the lungs, where it meets with the oxygen of the air; a slow combustion then taking place, which aids in the production of animal heat. But by a well conducted series of experiments by Dr. Pavy, it is shown that grape-sugar, if present in the blood, invariably produces diabetes, not being burnt off, but passing out of the system by the kidneys. The following are his views :—Just as, in the vegetable economy, starch becomes sugar before it is carried over the system of the plant, and

becomes again insoluble as lignin, or cellulose; so starch, in the animal digestive tract, after being acted on by the saliva (without which action starch is perfectly indigestible), becomes soluble sugar, preparatory to becoming insoluble again in the liver, as amyloïd matter, or insoluble liver-starch. The further destination of the amyloïd matter is not yet known; but it probably is changed into fat. This amyloïd matter is converted into grape-sugar only in disease, and as a result of death. The exact nature of the process by which amyloïd is converted into grape-sugar, in disease, is not precisely known; but some forms of nerve disturbance, and some chest affections, will act as exciting causes: so also will the eating of asparagus, of carrot, and dandelion. When this change is taking place, of course grape-sugar enters the blood, and passes off by the kidneys, the symptom called diabetes being produced. As regards treatment, Dr. Pavy recommends—not to refrain from drinking water, not to give acids as drinks. The food should consist of as much animal food (which is destitute of starch) as possible. Farinaceous and saccharine articles of diet to be most scrupulously avoided. By this means, the system being deprived of its principal source of sugar, the disease is held in check. Claret is the most suitable wine; dry sherry may also be drunk. Fat is suitable; and also cod-liver oil. A great desideratum in this complaint has been a kind of bread, so to speak, destitute of starch; the bran biscuits and gluten bread being very distasteful. Dr. Pavy has invented a very palatable substitute for bread, which is prepared under the name of almond food by a London baker, under Dr. Pavy's instructions; and which consists of eggs and blanched almonds, freed from sugar and gum, but retaining their oil.

SURGERY.

Removal of Portion of the Lower Jaw in a case of Fixed Closure.—A somewhat novel operation was performed by Mr. Christopher Heath, at the Westminster Hospital, London. The subject of it was a youth of fifteen, who for six years had been in the following distressing state.—The jaws were firmly closed on each other, the teeth of the upper jaw overlapping those of the lower: the only way in which food (and even then only soft, semi-fluid food) could be introduced into the mouth, was by coaxing it through a small aperture between two teeth on the right side. The boy was admitted on the 1st of July, in a most emaciated state; and on the 8th, chloroform having been administered, Mr. Heath removed a wedge-shaped piece of bone, by means of the saw, from the lower jaw on its right side, and consisting of its whole thickness. By this means a false joint was formed; and the operation succeeded so well, that when the boy was discharged in September (the wound being entirely closed), he was able to open his jaws to the certainly very useful extent of seven-eighths of an inch.

Oakum as a Substitute for Lint.—Dr. Sayres, surgeon to the Bellevue Hospital, in New York, states that for many years he has had a decided preference for picked oakum as a substitute for the much more expensive surgeon's lint. His recent ample experience as an operator confirms him in this view. Lint, in fact, especially when composed of cotton, is rather

an obturating (closing-up) than an absorbing agent, being wetted by the discharges from a wound only at the point of contact, its substance never being traversed; and thus the passage is obstructed rather than favoured. Picked oakum, on the contrary, becomes soon saturated, and keeps the surface of a wound clean and dry. It drains off the discharges like a syphon, rendering it necessary to place india-rubber sheeting or oiled muslin under the wound. When there is much inflammation, if the oakum be wetted in cold water, and the air excluded by wrapping a little oiled muslin round the part, a neat and comfortable poultice is secured. When a ball has traversed the parts through and through, a few fibres of oakum passed through by means of an eyed-probe will keep the wound fresh and clean. The insignificant price of oakum is another strong recommendation.*

Removal of Tumours from the Windpipe by the Aid of the Laryngoscope.—The Laryngoscope is an instrument, the honour of inventing which is claimed by some for Professor Czermak, by others for Signor Garcia, the celebrated singer. It consists essentially of a little square steel mirror, and a reflector. The mirror is pushed to the back of the throat above the opening of the windpipe, and light thrown on it from the reflector: the reflector itself being illuminated by a lamp. By this means, the interior of the larynx (*i.e.* the upper part of the windpipe) may be clearly seen reflected on the mirror. The subject of the above operation applied to Dr. Gibb, of Portman Square, for hoarseness and partial loss of voice, which had existed for twelve years, and had resisted every tried method of treatment. By the aid of the laryngoscope, Dr. Gibb discovered two small tumours, the size of peas, situated within the windpipe. These were removed; and the complaint that had existed for twelve years completely disappeared.

Astigmatism.—This is an affection of the eye, which has hitherto been considered rather a rarity, but which Professor Donders has lately shown to be not uncommon, occurring in about two out of every hundred that have been seen by him for weakness of sight. It consists in an unequal degree of curvature, on comparing two principal sections (meridians) of the cornea. The result is, that objects are seen further off in one meridian (say the vertical one) than in the other (the horizontal). In the case of the present Astronomer Royal, the furthest point of distinct vision in the erect meridian was three and a half inches, whilst in the transverse meridian it was five inches. As a consequence, points are seen as lines: whence the name, from *a*, without, and *stigma*, a point or mark. The following proceeding will make manifest the affection, if present:—A luminous point, as the sunlight streaming through a small hole in the closed shutters, is looked at; and between the eye and this point are passed in succession, a slightly convex and then a slightly concave lens. The point of light will alternately appear extended in two opposite directions, that is, vertically and horizontally: the direction of the line, under

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* "American Medical Times," vol. v. No. 6.

the use of convex glass, is the same as that of the meridian of greatest curvature; whilst the concave glass shows the direction of least curvature of the cornea. The remedy consists in the use of cylindrical glasses, made by dividing a glass cylinder parallel to its long axis. A glass prepared in this way exerts an influence on light falling on it in a plane perpendicular to its axis, whilst on light falling in a plane parallel to its axis it has no effect; so that the faulty diameter of the cornea is compensated for, and the correctly curved diameter is not interfered with.

Transplantation of Teeth.—At the congress of German dentists, held in September, 1862, M. Süersen, of Berlin, stated that he considered Faulkner's orange vulcanized india-rubber as preferable to all other kinds: he had analysed it, and found it innocuous. When made up for the purpose of fitting in artificial teeth, it was necessary, he found, to subject it for an hour and a quarter to steam, heated under pressure to between 360° and 386° Fahrenheit. He also stated that transplantation of teeth had been practised by Mitscherlich of Berlin for the last eighteen months. His method was to implant into an empty tooth-socket, a human tooth that had been extracted some time previously. The tooth itself took no part in forming the union; but material was thrown out by the socket which firmly fixed the tooth in its place. The chief conditions of success were, that the individual should not be too old, should be in good general health, and the socket for the tooth should be sufficiently large. Mitscherlich had been successful in eight cases out of ten. M. Süerson himself, owing to want of good selection of teeth, not quite so fortunate.

THERAPEUTICS.

Nicotine as an Antidote to Tetanus.—In November, 1856, the Rev. Professor Haughton, of Trinity College, Dublin, read a paper in the Royal Irish Academy, in which he showed that in frogs poisoned by strychnia, the effect of the poison is counteracted by nicotine (the active principle of tobacco). The causes of tetanus are chiefly three; that form which arises from the irritation of certain kinds of wounds, conjoined probably with atmospheric influences; that form arising from no ascertainable cause (of course there *is* a cause, but it cannot as yet be traced), in which, however, there is generally a story of exposure to cold and wet; and, lastly, the form which results from the taking of strychnia. The first species is called Traumatic; the second, Idiopathic; the third, differing slightly in its symptoms from the other two, is Tetanus from strychnia. To resume; in 1858, Dr. T. O'Reilly, of St. Louis, Missouri, in a case in which six grains of strychnia had been swallowed (a poison so virulent, that half a grain is sufficient to destroy adult human life), brought the patient round again, by administering an infusion of dry tobacco leaves. Dr. Haughton has lately published a pamphlet on the subject, in which he gives the result of treatment by this method in four cases. The first case was traumatic, and the patient was dying when seen; but the effect of the nicotine was well marked, although life was not saved. The nicotine was given in one-drop doses: there was an immediate relaxation of the tetanic spasm in the muscles of the face, throat, and chest. The second case was

idiopathic; there had been exposure to cold. The patient recovered entirely in eleven days; during which 44 drops, or 26·4 grains of nicotine, were taken by him. The effect of the nicotine was as follows:—There was an immediate relaxation of the muscles of the back, abdomen, and chest; a cessation of delirium; a slight increase in the number of pulsations at the wrist; profuse sweating—the perspiration having an intolerable odour of snuff; and a tendency to deep sleep. The third case was that of a boy who was treated in the Meath Hospital, by Dr. P. C. Smyly: the boy had taken four grains of strychnia; and in his case, emetics had been given with effect. An ounce of cut cavendish was put into a jug, and a pint of boiling water poured on cold water was then added, until the contents of the jug were tepid. This was taken at twice, and was followed by vomiting. Another pint made in the same way with another ounce of tobacco had the same effect. A third pint made from the same ounce was partly retained by the stomach: profuse sweating and sleep came on: in half an hour there was complete relaxation of the muscles, and the boy recovered rapidly. The fourth case was traumatic, coming on after a compound fracture (fracture with communicating wound) of the fore-arm. During four days, 54 drops of nicotine, equal to 32½ grains, were given; and recovery took place.

Tannin as an Antidote for Strychnia.—M. Kurzak, in the *Journal de Chimie Medicale*, concludes from his experiments, that if administered in time, tannin is an excellent antidote to this poison. Twenty or twenty-five times as much tannin (the active astringent principle in oak-galls, &c.), as the amount of strychnia taken, must be given; and it would be prudent to give it even in larger proportion. Infusion of galls, even of black tea (if but little strychnia has been taken), of acorns, chestnut-bark, willow-bark, oak and elm-bark, tormentilla-root, or of the root of the carnation, may any of them be given, as these substances are rich in tannin. A great recommendation to nicotine and tannin is, that both are easily obtained in almost every dwelling.

Sarracenia Purpurea in Small-pox.—This plant, the Indian cup, a native of Nova Scotia, has recently been much spoken of as a remedy for small-pox, the course of which it is said to shorten, and also to prevent entirely the disfiguring pitting which so often follows this disease. Dr. Manning, of York, however, states that he has given the Sarracenia Purpurea a good trial, and he finds that it has no effect at all, either in checking the course of small-pox, or in preventing pitting.

Formation of Cinchona Plantations.—The rapid destruction of whole forests of the cinchonas (from which Peruvian bark and quinine are obtained), for the purposes of trade, without corresponding restoration by means of the growth of fresh trees, has led to great fears that in time we should be totally deprived of this valuable tree. To prevent this, our Government has been forming plantations of cinchona on a large scale, which are situated on the Neilgherry hills. The total number of plants at present is 72,568. Of these, 13,700 are placed permanently out of doors; 18,076 are in the plantation nurseries; and 40,792 are small, and under glass. Extensive clearings are being made: the Denison and Markham plantations, both at Neddiwuttum, together contain 410 acres. Another

plantation is being formed at Pycarrah, of 250 acres. In addition to this, private individuals are anxious to grow the cinchona, and have already bespoken 22,000 plants.

MISCELLANEOUS.

At the Pathological Society of London, last October, Mr. Canton showed a horn which he had removed from the upper eyelid of an old woman; it commenced as a wart four years ago, and had attained a considerable size.

The total number of in-patients admitted into the wards of all the London hospitals together, during 1861, amounted to 35,506,—a number surpassing the entire population of many a provincial town, and exceeding that of one English county. The whole number of in-patients in all the London hospitals on the night of the last census was 5,625.

M. Reviel has instituted a series of experiments at the Hôpital Lariboisière, Paris, and has shown the existence of a large amount of organic matter floating in the atmosphere. The dust of a ward was collected and found to contain 36 per cent. of organic matter, chiefly in the form of epithelial cells. In the air of rooms containing the sufferers from contagious inflammation of the eyeball, small corpuscles were detected analogous to those of the virus thrown off from an inflamed eye. It is probable that infection, therefore, is mechanically conveyed from eye to eye by means of the air.

In the course of one week, Dr. Letheby detected in the City of London no less than 4,525 lb. of meat and seventy-three head of game exposed for sale, but totally unfit for human food. This amount was made up of sixteen sheep, ten pigs, thirty-two quarters of beef, and about fifty joints of meat beside.

Dr. Ogilvie, of the Native General Hospital, Alexandria, lately removed from a Turk, a native of Adalia, in Asia Minor, a large tumour of the abdomen, the result of Arabian Elephantiasis. The weight of the tumour was forty-three pounds: the man made an excellent recovery.

Mr. Glaisher, in his recent scientific balloon ascent, found that as a rule the number of beats of the pulse was increased the higher he rose. At the height of 29,000 feet above the earth he became insensible; and it is interesting to note the order in which he lost the use of his powers. In the first place, he felt an inability to move his limbs; then to keep his head erect; then his body fell to the floor of the balloon-car. Suddenly an intense darkness came over his sight; still he could hear; his hearing then went, and lastly, his self-consciousness: he felt as if going to sleep. Through the presence of mind of Mr. Coxwell, his companion, who was, however, becoming temporarily paralyzed himself, and who had to open the escape valve for the gas with his teeth (his hands failing him), both valuable lives were saved. During the ascent there was no evidence of either intense cold, or of embarrassment in breathing.

The loss of infant life in Sheffield (that is, in children from birth to five years of age) is one-half of the whole number of deaths.

MICROSCOPE.

Supposed Discovery of a Microscopic Vertebrate Jaw. — Dr. Wallich figured the "Annals," a minute object which he had found upon a slide containing mud, dredged off St. Helena. It was about the $\frac{1}{100}$th of an inch in length, and bore so remarkable a resemblance (as the writer can vouch from personal examination of it) to the lower jaw of some mammalian animal, that it has been a puzzle to naturalists, who have referred it—some to the mandible of a fish; others to the lingual ribbon of a *mitra;* others to the claw of a minute crustacean; and others yet again to the valve of a *pedicellaria* (or minute process found upon sea-urchins). After due consideration, no one now believes that it ever formed part of a vertebrate animal; but its interest as a pseudomorph (or imitator of another natural form) is undiminished. Mr. Spence Bate makes out a good case for its being the last joint of the leg of a small hyperine crustacean, of the genus *Phrosina*, which is very abundant in the tropical and subtropical Atlantic Ocean. Dr. Wallich himself inclines to favour the opinion of Mr. Busk, who shows the extremely close analogy between the object in question and certain Pedicellariæ.

Presence of Acari in Solutions.—The circumstance mentioned in the last number has received elucidation from a paper by Mr. Shadbolt to the Microscopical Society. The Acari found in these unusual situations appear to belong to a widely diffused species, which has been found adhering to the walls of a room in great numbers, whence they make their way into the solutions. The remarkable fact still remains, however, of their being found in strong nitrate of silver baths, which might be expected to be fatal to animal life. It is probable that the *Acarus Crossii*, at one time supposed to have been produced by the electrical experiments of Messrs. Crosse and Weeks, was of the same species.

Urticating Filaments in Mollusca.—Dr. Bergh, of Copenhagen, has shown that these minute organs exist not only in Hydra, the Actiniæ, and the Medusæ, but also in several Molluscs. He has demonstrated the existence of true urticating batteries of sacs filled with *cnida* (or nettling filaments) in the typical forms of Eolidæ, and in several other genera of naked-gilled Mollusca. They may be almost regarded as a family character. In every case they are planted at the extremities of the papillæ, above the hepatic lobe, in a sac opening to the exterior by an extremely minute pore at its summit. Although called urticating filaments, it is probable that they have not a true urticating function; for stinging is not always a concomitant of their presence, as in the case of these Eolids. The use of them must, therefore, be regarded as at present unknown.

New Method of preparing Algæ, &c.—Professor Reinicke recommends the following mixture as a dense, non-drying fluid, which prevents the shrinking of soft tissues; viz. alcohol (90°), 3 parts; water, 2 parts; glycerine, 1 part. The spirit, being lighter and more limpid than water, compensates for the greater density of the glycerine. The preparation

being placed on the glass slide in a drop of water, another drop of the above mixture is added to it, and it is placed aside, secure from dust, to evaporate till nearly all the fluid is gone. A second drop is then added, and so on, until a sufficient quantity of the non-drying material is left to cover the object. The glass cover should not be put on until all the evaporable part is gone. In this way M. Reinicke has succeeded in retaining the natural *form*, *colour*, and structure of delicate filamentous algæ, fungi, and animalcules; and objects taken in the act of fission, conjugation, &c., remain unchanged, and as useful as living subjects.

MINERALOGY, METALLURGY, AND MINING.

MINERALOGY.

THE composition of *Meteorites* is a subject which is interesting, on the ground that they are generally supposed to have their origin independently of the Earth. We are always curious to obtain any information which shall throw light upon the constitution of the various members of the solar system; we wish to know whether the other worlds are like our own. With the exception of the recently discovered spectrum analysis, we have few means of obtaining such information beyond the examination of fragments, such as meteorites, which have strayed out of their course, and come under the influence of the Earth's attraction. Here, if anywhere, we may expect to find elementary substances not to be found in terrestrial nature. So far, however, no such discovery has been made; the same elements, and frequently the same compounds, are found in these strange visitors, as those with which we are already familiar. On the 1st May, 1860, a meteoric stone fell at Guernsey, Ohio; which was subsequently examined by Dr. J. Lawrence Smith, Professor of Chemistry in the University of Louisville, Kentucky. He states that there were three or four explosions, like the firing of cannon, at intervals of a second or two, then sounds like musketry, and finally a rumbling. Above thirty stones fell, the largest weighing 103 lb. All the stones had a black coating, 1-30th to 1-40th of an inch in thickness. On being broken, they showed a grey mass, with particles of nickeliferous iron. Ten minutes after the fall they felt as warm as if they had been lying in the sun; and he concludes that their temperature on falling must have been short of redness, and may have been less than 200°. On analysis they furnished 11 per cent. of nickeliferous iron, and 89 per cent. of earthy matter. The latter he concluded to be in the main a mixture of olivine and pyroxene. His conclusions regarding meteorites he sums up thus:—1. The light emitted by meteorites is not from their incandescence, but from electricity or some other cause. 2. The noise they produce is not from the explosion of a solid, but from their rapid motion, or in part from electrical discharge. 3. Meteoric showers do not result from the rupture of one mass, but from a separation of distinct meteorites, which have entered the atmosphere in groups. 4. Their black coating is already formed when they enter the atmosphere.

A meteoric stone fell at Chassigny, near Langres, in October, 1815, and was described by Vauquelin. It has been lately re-examined by Mr. A. Damour, who was led to notice the similarity in its composition to one of the species of the mineral peridot. [Peridot, or chrysolite, is the name given to the paler and more transparent crystals of olivine.] His own analysis confirmed this supposition. The stone differs from the majority of meteorites by its pale yellow colour. It contains neither nickel nor iron in the metallic state; and it is not magnetic, with the exception of a thin black crust covering it. This seems to indicate, that during its incandescence, the protoxide of iron which it contained became converted into black or magnetic oxide. On analysis, the substance of the stone furnished 35 per cent. of silica, 32 of magnesia, and 27 of protoxide of iron; agreeing in composition with the ferruginous variety of peridot, called Hyalosiderite. [This mineral is found in a brown basaltic rock at the Kaiserstuhl, in the Breisgau.] Several mineralogists have established two chief classes of meteoric stones:—1. Those containing alumina, and which may be considered as belonging to the Felspar family. 2. Those containing no alumina, but more or less of magnesia, oxide of iron, lime, &c., most probably in the form of pyroxene and magnesian silicates. Mr. Damour would place the Chassigny stone in the second of these classes.

Effects of heat on Felspar.—M. des Cloizeaux has examined the molecular changes produced in certain minerals by the action of heat. By means of a polarizing microscope he could detect any alteration in the relative directions of their optic axes. Many crystals have the property called "double refraction;" that is, they split up a ray of light passing through them into two parts. But there is one direction in each crystal, sometimes two, as in felspar, in which there is no double refraction; these directions are called the optic axes of the crystal. In a small plate of orthose (or common felspar, so often found in granite and other rocks), the optic axes separated the more, the higher the temperature was raised. On cooling again, they returned to their original condition; showing, therefore, no *permanent* modification. He found, however, that if the substance were heated for thirty-six hours to a dull red, or for fifteen minutes to a white heat, a permanent change was effected. His experiments have led him to conclusions contrary to the hypothesis which admits the necessity of an excessive temperature to explain the formation of crystalline rocks where orthose and quartz predominate; and he has found the same thing to hold with other varieties of felspar. On the other hand, several varieties of the same mineral show neither temporary nor permanent modification under the influence of heat; and he infers that they have not been subjected in nature to the same influences as those previously referred to.

Esmarkite was the name given by Erdmann to a mineral found at Brakke, in Norway. M. Pisani has shown, however, that the name has in reality been given to two species of Norwegian minerals which are distinct; and he recommends, therefore, that the name be suppressed altogether.

Mineral Wealth of Australia.—The *Melbourne Argus* has recently given a series of letters from a correspondent deputed to examine the mineral

resources of Australia. His reports are particularly cheering. They show that even in their oldest gold-fields, mining is yet in its infancy. Alluvial fields are still unexhausted, and auriferous quartz reefs without number lie untouched in every district for want of capital and labour.

The correspondent also draws attention to mines of antimony, silver, and iron; of which little or nothing was before popularly known.

Gold in Wales.—During the past quarter, mining periodicals have been thickly strewn with reports, generally very sanguine, of the progress of gold mining in the principality; with analyses of the quartz, and latterly with prospectuses of companies and their usual accompaniments. No further agitation is required to bring the subject under the notice of the mining or share-dealing public.

Mr. Readwin, the pioneer of this enterprise, read a very interesting paper on the subject before the British Association, to which we refer our readers.

METALLURGY.

In these days of armour-plates and monster cannons, the manufacture of *iron* holds the first place in metallurgical interest. The magnitude with which iron smelting is conducted may be judged of by the following items, taken from Truran's new work on the iron manufacture of Great Britain. At Dowlais, the weekly make of iron is about 130 tons, and the ordinary weekly amount of slag, 250 tons. The materials delivered weekly at the top of the furnaces would occupy 1,066 cubic yards. The air delivered in the same time by the tuyeres (*i.e.* the nozzles of the blast apparatus) weighs 1,695 tons and measures 50,550,400 cubic feet. Each ton of iron is reduced by 43·5 cwt. of carbon, and 388,800 cubic feet, or 13 tons of air. The weight of air is to the weight of material added at the top, as sixteen to seven. For each ton of liquid matter obtained (that is, including both iron and slag), no less than 129 cwt. of gases are evolved from the furnace.

Puddling by Machinery.— In the conversion of cast-iron into malleable iron by the process of puddling, the most intense bodily labour is involved; whilst the workmen are exposed to an overpowering heat. It is, therefore, satisfactory to find that machinery has been introduced into the process—an invention having been patented by MM. Dumey and Lemut, of St. Dizier, France, through a London agent.

Effect of Wolfram on Steel.—A series of experiments have been carried out by direction of the French minister of war, to ascertain the effect of the addition of wolfram to bronze, wrought-iron, and steel. The report states that there is no advantage to be got by adding it to bronze, and probably little in the case of wrought iron; but that wolfram may safely be recommended to give to steel qualities which increase its value considerably. It concludes by saying that the small addition which would ensue in the price of the steel would be far more than counterbalanced by the advantages obtained.

MINING.

THERE is considerable interest in examining the traces which are left to us of mining as practised by our predecessors in ancient times. It has often been found that the materials thrown aside as useless by miners and smelters in former times turn out on examination to be exceedingly rich in metal. Professor Ansted reports the discovery in the Mendip Hills, about three miles from Wells, Somersetshire, of a deposit of lead, producing *débris* of old mines and lead washings of ancient miners, filling up the bed of a stream that flowed in former ages. This metallic slime of exceeding richness amounts, he says, to 600,000 tons, extends over 25 acres to the depth of 30 feet, and is computed to be worth half a million sterling.

Early British Tin-Works.—Mr. Hunt remarks that there is little doubt that tin was procured from the rocks, and collected by washing from the streams of Cornwall and Devonshire, long before the invasion of Britain by the Romans. He thinks it probable that the bronzes which decorated the palaces of the kings of Babylon and Nineveh were manufactured of British tin.

In a paper on the Remains of Early British Tin-Works, read at a meeting of the Cambrian Archæological Association in the beginning of September last, Dr. Barham states, that the evidences of very ancient tin-workings are still to be found in many parts of Cornwall and Devonshire. In St. Just, near Cape Cornwall, there are rude workings which are probably early British. In other places there are excavations showing that remarkable want of engineering knowledge which distinguishes all early workings. Many of the old workings belong without doubt to the Roman period, and there is evidence that the educated skill of the Romans was brought to bear upon their Cornish tin mines. They even executed a large *arched stone level*, very different from any other of the "old men's workings." The description agrees with that of Roman works in Spain.

Lead.—In the International Exhibition was a pig of lead of the Roman period, as well as two photographs of an ancient mine in the Shelve district, Shropshire.

Iron.—During the summer of the last and present years, explorations have been made in the Cheviot district, resulting in the discovery of a walled town, several fortlets, scattered hut circles, and tumuli of the Celtic period. The discovery of pieces of iron slag gives a new view of Celtic life, as a general impression prevailed among antiquarians, that the ancient Britons were not acquainted with the art of smelting.

Electric Lamp.—Few improvements have been made in the safety-lamp since the time of Davy and Stephenson. Its safety lies rather in the warning it gives of the presence of gas, than in allowing the miner to work in a dangerous atmosphere. No miner should remain in a place which his lamp shows him to contain an explosive mixture of gases. MM. Dumas and Benoit have invented an apparatus for lighting miners, the source of illumination being induced electricity. Their apparatus consists of three parts —(1) an element of a pile; (2) a Ruhmkorff's coil; and (3) one of

Geysler's glass tubes ;—the whole so disposed as to furnish a light sufficient for working, even where other lamps go out. [It is quite certain that where lamps go out the atmosphere is unfit for breathing ; nevertheless, it might be necessary to explore it temporarily.] The light produced does not heat the tube, and is inaccessible to the gas; there is consequently no danger of firing the explosive mixture outside. The whole apparatus is perfectly isolated ; it is as solid as the lamps now used ; gives off no noxious vapour, and may be relighted at any moment. It can act for at least twelve consecutive hours without diminution of light.

PHOTOGRAPHY.

HER MAJESTY has been graciously pleased to authorize the presentation to each member of the London Photographic Society of a copy of the excellent photographic portrait of the late Prince Consort, taken by Mr. Vernon Heath. The Council have already taken steps to avail themselves of the privilege granted by the Queen, and will shortly be in a position to issue the requisite number of prints, which will be distributed to all subscribers for the current year.

A faithful *carte de visite* portrait of Mr. Hardwich has, to the extent of one hundred copies, been distributed, by Mr. St. George, amongst the members of the North London Photographic Society.

As evidence of the appreciation of Photography, as a branch of the Fine Arts, it is satisfactory to notice the recent announcement of the Glasgow Art-Union. It has this year been decided to issue to the subscribers, instead of the usual guinea engraving, three large photographic reproductions from original paintings. The subjects respectively are—"The Better Land," by G. J. Sant, A.R.A. ; "The White Cockade," by J. E. Millais, A.R.A. ; and an illustration from Tennyson's "Morte d'Arthur," by Noel Paton, R.S.A. The original paintings are intended for distribution, as prizes, and the reproductions, by Mr. Annan, of Glasgow, are in themselves first-rate examples of photographic art.

The opinion we ventured to express in our last with regard to the causes of fading so lamentably manifest in the Gallery of Photographs lately forming part of the International Exhibition, has received a signal confirmation from a specimen in the possession of Dr. Diamond, to which Mr. Malone took an opportunity of referring at a recent meeting of the London Photographic Society. The print in question was covered with the usual pasteboard mount and glass in front ; and although for several months it had been freely exposed to the light, had not suffered any apparent deterioration. On removing the print from its frame it was found, however, to be very much faded in those parts which were obscured by the mounting-card, so that the oval figure of the latter was clearly discernible upon the face of the print ; and thus it appeared that exposure to the light and warmth of the sun had been directly instrumental in preserving the photograph from change, no doubt by aiding the evaporation of the hygroscopic moisture from the central portion of the picture, and there maintaining a drier condition of surface than was possible in other parts which were

never brought under the protecting influence of sunlight. An observation which points to the same conclusion, is the greater degree of permanence manifested by such prints as are freely exposed to air and light in shop-windows, as compared with the condition of others kept for stock in port-folios. The exceptions to this rule of general experience are rare, and appear to be such instances only as are obviously favoured by the maintenance of a high temperature or unusually dry atmosphere in their vicinity, and where, consequently, the proportion of hygroscopic moisture absorbed by the prints, their paper mounts, and adhesive backing, is reduced to a minimum.

The composition of the photographic image has again been brought prominently into notice by the lecture delivered by Mr. Malone on the occasion already alluded to (December 2nd, 1862). The experimental facts urged in favour of the truly metallic nature of the darkened particles which constitute the shadows of the picture, were based upon the result of exposing to sunlight a solution of ammonio-nitrate of silver, which had by repeated use become contaminated with sundry organic matters derived from the paper. The product was very similar to that before obtained by Mr. Spiller in working upon chloride of silver in an extremely fine state of division; there was no doubt that the dark grey particles were composed entirely of metallic silver, since they imitated all the reactions of this elementary substance, and remained insoluble and unaffected by the several chemical agents usually employed in the process of fixing the photographic image.

The Council of the London Photographic Society have decided on giving prize medals at the next exhibition of the Society. It is believed that four silver medals will be awarded: one for the best landscape; one for the best portrait; one for the best example of photographic art, whether a composition, picture, or copy of a work of art; also, for discovery or excellence of manipulation. The exhibition will probably be held at the Suffolk Street Gallery early in 1863.

The Marseilles Photographic Society have appointed a commission to inquire into the practical value of a suggestion made by M. Megnier, to employ the sulpho-cyanide of ammonium as a fixing agent in photography. The aqueous solution of this salt is said to dissolve the chloride and iodide of silver as freely as does hyposulphate of soda, at the same time not being liable to permit the formation of the black sulphide of silver on standing at rest, or by contact with the free nitrate on the surface of the print.

A proposition of great importance has, during the past three months, occupied a large share of attention on the part of practical photographers. It has reference to the use of certain gum-resins for the purpose of imparting to paper a close texture and lustrous surface, which qualities have hitherto been secured only by the use of albumen. Our most eminent photographic artists have long agreed in condemning the use of albumenized paper, as being altogether unsuited to the representation of many subjects, on account of the excessive and often objectionable glaze apparent on such prints; its employment seemed however, virtually, a necessity, from the difficulty of rendering by other means the details in shadow. The all but

universal employment of albumenized paper appears likely to suffer a severe check by the introduction of the resinized surfaces of Mr. Cooper. Several formulæ have been announced in which as many different gum-resins have been selected to fulfil the object in view. It is scarcely probable that the details of the new process should already be incapable of improvement. Gum benzoin was first used, but the recommendation at present is in favour of the employment of a mixture of frankincense and Chio turpentine—one ounce of the former and one drachm of the latter being dissolved in half a pint, or rather less, of methylated spirits of wine, with the addition of two drachms either of the chloride of cadmium or zinc, to furnish the necessary element for the formation of chloride of silver. The resin-paper is prepared merely by immersing in this alcoholic solution for about five minutes the papier Saxe or Rives, gradually lifting and removing the sheets, draining, and drying rapidly before a fire; they are made sensitive by floating on a solution of nitrate of silver (sixty grains or upwards to the ounce of water), and when dry are ready for the printing-frame. It is necessary to print deeply in order to allow for a considerable loss of vigour always experienced in the after processes of fixing and washing. The specimens which have been exhibited as the results of this process justify the hope that we shall shortly be placed in possession of a system of photography by which more artistic effects may be produced with greater ultimate security upon the score of permanence.

We may judge of the commercial success which has attended the operations of the Contractors for Photography at the International Exhibition, by the announcement made by Mr. England in reference to the quantities of paper and chemicals used during the busy period of six months that the Exhibition building has continued open to the public. The sale of photographs is not likely, however, to be restricted to the *quarter of a million* stereoscopic slides already disposed of. The materials used amount in round numbers to the following:—

White of egg	200 gallons.
Paper	70 reams.
Nitrate of silver	2,500 ounces.
Metallic gold	35 ounces.
Hyposulphate of soda	25 cwt.

Among the novelties in apparatus may be mentioned the beautifully moulded glass dishes of Messrs. Chance, intended specially to hold the nitrate of silver, a corrosive agent which the ordinary glaze upon earthenware is not well able to withstand. The "Patent Ebonite" baths and other apparatus, manufactured by Messrs. Silver and Company, are, on account of their lightness and portability, exceedingly well adapted to the wants of the photographic tourist. They are made of india-rubber hardened by exposure to a higher temperature than that usually employed in the process of vulcanization; the material is consequently unaffected by boiling water, and although sufficiently elastic, is yet firm and rigid. It can be moulded almost to any shape, takes a beautiful polish, and is so light that an ebonite bath complete, with dipper, air-tight cover, and damp-screws, weighs considerably less than the silver solution contained

in it. A stoppered bottle, made to hold a pint of water, weighs when empty but four ounces, a mere fraction when compared with its weight when filled. The shallow dishes or trays, developing cups, funnels, and other smaller requisites, may likewise be procured of this material, all of which are proportionately light and compact.

A very perfect description of prepared silk for covering the windows of the dark room has recently been introduced by Mr. Smartt. It consists apparently of two layers of oiled silk, with a deep orange, almost scarlet, pigment laid between; it is uniform in colour, and very durable. The material is made in pieces measuring three feet by eighteen inches, and a single thickness is sufficient to cut off all the chemically active rays of sunlight.

It is well known in London, that for five shillings may be purchased very beautiful reduced photographic copies of Rosa Bonheur's "Horse Fair," and Holman Hunt's "Light of the World;" the original engravings, by Mr. Thomas Landseer and Mr. Simmonds respectively, costing as much as ten guineas. The copyright of these works of art being held by Mr. Gambert, of Pall Mall, that gentleman has thought proper to take law proceedings, in order to protect himself against the piratical imitation, by means of photography, of these and other engravings published by him. The question of copyright has therefore been repeatedly discussed in the course of the arguments advanced by the plaintiff and defendants in these actions. It cannot, however, be said to be well defined, when it has been found necessary to refer back to Acts of George III., so long before the invention of photography, and when the words "fac-simile" and "main design" were intended to apply to copies or reproductions of the same size and style, and to such works as would be likely to deceive the purchaser at the time of making his bargain. It is clear, then, that a special Act must be obtained of more general application in these cases, and that the copyright of an engraving must forbid alike the reproductions of photography, as well as all other attempts by older processes of imitative art.

PHYSICS.

LIGHT, HEAT, AND ELECTRICITY.

SEVERAL papers have been published since our last number, somewhat modifying our views of the supposed rigidly definite character of spectrum analysis. M. Plücker, in a letter in the "Cosmos," shows:—1st. That the spectra of gases and vapours vary with the power of the induction coil, and show a tendency to continuity by spreading of the rays. 2nd. That this variability and spreading are caused by rise of temperature, so that the number and kind of the rays are dependent upon the temperature to which the gases are subjected in the capillary tubes. And 3rd. That by simultaneously increasing the density and temperature of highly rarified gases, there may be made to appear and disappear the various rays which constitute their spectra—alternated, separated, and reunited by the power

of the heat. He has operated upon oxygen, nitrogen, chlorine, &c.; and in a second letter gives additional details, and states that glass tubes open at both ends may be employed instead of the usual ones, which are hermetically sealed.

Mr. J. H. Gladstone, F.R.S., has published in the "Philosophical Magazine" a paper "On the Violet Flame of many Chlorides." He says it is popularly known, that if common table-salt be thrown on red-hot coals, it produces violet flames, whilst by the ordinary method of examining bodies by prismatic spectrum analysis, it is well known that that substance gives rise to the yellow double line D.

Many other chlorides, for instance, the chlorides of copper, potassium, barium, platinum, gold, mercury, &c., also give the same violet light when sufficiently heated, but not the chlorides of calcium, lead, or magnesium, and these flames, when analysed, are found to consist not of the yellow light, but of *three* groups of lines; the first green, the second bluish-green and blue, and the third violet. To obtain the violet with chloride of barium, the heat must be much more intense. He concludes that the violet light of these substances is not due to the chlorine combining with the hydrogen or the carbon of the combustible, nor produced by the chlorine when it is decomposed by heat; and that the origin of the violet light requires further elucidation.

Alexander Mitscherlich, in a recent number of Poggendorff's "Annalen," has shown that the prismatic spectra of the flames of certain compounds of the metals are different from those of the metals themselves. He gives drawings of the spectra obtained from four different chlorides and one iodide, and shows the bearing of his observations upon solar chemistry and other questions.

Dr. Robinson has published in the "Proceedings of the Royal Society" an abstract of a paper "On the Spectra of Electric Light, as modified by the nature of the Electrodes and the Media of Discharge." He expresses his belief that spectrum analysis is not that invariable or absolute test of the presence of certain substances as is generally supposed. He made numerous experiments, in which the media of discharge were air, nitrogen, oxygen, hydrogen, and carbonic oxide, including in some instances the vapours of mercury, phosphorus, and bisulphide of carbon; he employed as electrodes, graphite, and twenty-three different metals; and obtained 185 *different* spectra, which he examined and measured. His conclusions are:—1st. That many lines are found in *all the gases*, and in many, *perhaps all* the metals; the existence of *such* lines must therefore be independent of the chemical nature of the substance. 2nd. That on varying the density of the gases, the spectra were found to vary, showing that the character and even the existence of certain lines are dependent upon the mere density of the medium, whilst the chemical conditions remain unchanged so far as the presence of the given substance is concerned. 3rd. That in the case of the presence of more than one substance, the spectra of the substances present are not merely superimposed without change, as has been generally believed; and that there is even reason to believe, that for certain lines, the action of different bodies upon each other may be antagonistic. And 4th. That the brilliancy of the lines is very

little increased by greatly increasing the heating power of the electric discharge. If these results are confirmed by other investigators, we shall have to be much more careful in employing spectrum observations for the purpose of chemical analysis, and to learn what conditions modify the appearance of the lines before we can safely use them for that purpose.

MM. Wolf and Diacon, in a paper published in the *Revue de Sociétés Savantes*, have described a method they employ in spectrum analysis. They volatilize the substance to be examined by heat in a current of hydrogen, and ignite the escaping jet of hydrogen in contact with a jet of pure oxygen, and state that under these conditions many metallic chlorides, but especially alkaline metals and their volatile compounds, produce perfectly distinct and very lasting spectra.

Sir David Brewster, in a paper "On the Action of various coloured Bodies on the Spectrum," in the "Philosophical Magazine," Dec. 1862, has published his observations on the action of numerous solids, liquids, and gases on the solar spectrum. The substances employed include solutions of alkanet-root, cochineal, chica, cudbear, sulphate of indigo, sulphate of chromium, nitrate of cobalt, litmus, sulphate of copper, sulphate of ammonia and chromium, chromate of ammonia, sulphate of cobalt mixed with chromate of ammonia, sulphate of potash and nickel, carbazotate of potash, ferriocyanide of potassium, sulphate of potash and copper, bivanadiate of ammonia, chloride of iridium and potassium, carbazotic acid, ammoniuret of nickel, nitrate of copper, nitrate of nickel, ammoniuret of copper, chloride of copper, sulphate and nitrate of iron, chromate of potash, oxalate of chromium and potash, and arsenite of copper dissolved in hydrochloric acid.

In a paper communicated to the British Association, J. H. Gladstone, Esq., F.R.S., calls the attention of scientific men to those lines of the solar spectrum which are due to the terrestrial atmosphere, and incites observers to watch those lines and bands under every possible variation of circumstances, such as at different periods of the day and year, at different altitudes, &c. &c. By the aid of a portable spectroscope, he has made numerous observations of the kind, and has observed several bands not recorded in the map of Sir David Brewster and himself in the "Philosophical Transactions," 1860.

Dr. A. Weiss has been making spectrum observations in Greece: he succeeded in observing, in a surprising manner, a condensation of the lines of the red and yellow portions of the spectrum, and considers that, from the purity of the sky, Greece (and especially the Ionian Islands) is very suitable for spectrum observations.

M. Brachet has proposed as an improvement, in applying the electric light, to inclose the light within a globe of uranium glass, and that again within a second glass globe, of such a colour as to correct the greenish tone of the resulting light; and the proposal has been referred to MM. Regnault and Babinet for consideration.

The "motion of camphor towards light" has been the subject of a recent investigation by Mr. C. Tomlinson. He shows, by various experiments, that the crystalline deposits of camphor in bottles, which occur when that

substance is exposed to the sun's rays, are not due, as has long been supposed, to the agency of light, but are simply and purely a result of unequal heat, the crystals always forming upon the coldest side of the bottle. He has done the cause of science a service by correcting statements upon the subject which have been made in nearly all our leading chemical works.

Principal J. D. Forbes has published an elaborate paper in the "Transactions of the Royal Society of Edinburgh," "On the Conduction of Heat in Bars, and the Conducting Power of Wrought-Iron," and has observed that the order of arrangement of the "conductors of heat differs but little from their order of conduction for electricity," and thus confirms the results previously obtained by Wiedmann and Franz; also that "the diminished conducting power of iron, by increased temperature, harmonizes with similar facts in electricity."

M. Reitlanger has communicated a memoir to the Academy of Sciences at Vienna, "On the Sounds and Motion which take place within the Voltaic Arc." He employed Trevelyan's apparatus, driven by a voltaic current according to Mr. Page's process; and in some of the experiments the apparatus was placed in an exhausted receiver. He concludes that the sounds emitted by the above apparatus, as well as the motion of the revolving globes of Mr. Gore, are simply mechanical results of the electric discharge between the various movable metallic parts of the apparatus, where they are in imperfect contact with each other, and result especially from the tearing action.

Some interesting details respecting a discharge of lightning down a poplar tree are given in *L'Institut*. The lightning produced a groove like the furrow of a ploughshare, which did not proceed in a vertical line, but followed a spiral direction down the tree. It is interesting to notice this direction of action, as in another instance, at Birmingham, on the occasion of the Queen's visit to that place, lightning struck a pole fixed upon the Town Hall, and the direction taken by the electricity was also in that case in the form of a spiral down the pole.

ZOOLOGY.

M. du Chaillu and the Gorillas.—The long-vexed question of the authenticity of M. du Chaillu's travels in Equatorial Africa has received fresh light from Mr. W. Winwood Reade, who writing from Loanda, September 7, says:—

"Having spent five active months in the gorilla country, I am in a position to state that M. du Chaillu has shot neither leopards, buffalos, nor gorillas; that the gorilla does not beat his breast like a drum; that the kulu-kamba does not utter the cry of *Kooloo*, or anything like it; that the young gorilla, in captivity, is not savage; and that while M. du Chaillu affects to have been a *poor fever-stricken wretch* at Camma (June 1, 1859), he was really residing, in robust health, at the Gaboon."

Mr. Reade admits that—

"From the same source which afforded me proofs of his (Du Chaillu's) impostures, I learn that he is a good marksman; possessed of no common courage and endurance; that he has suffered many privations and misfortunes of which he has said nothing; that his character, as a trader, has been unjustly blemished; that his labours, as a naturalist, have been very remarkable; and that, during his residence in Africa, he won the affection of the natives and the esteem of those who most merit to be esteemed—the missionaries."

M. du Chaillu, not content with these concessions, in a letter to the *Times*, endeavours, from Mr. Reade's letter, to make it appear that the charges of misrepresentation still retained against him are groundless; and concludes by proposing that Dr. Gray and his friends shall deposit £2,000 on the one side, while he, on his part, will deposit £1,000; and, this being done, he will repair to the gorilla country, and if he succeeded in two years in bringing home eight perfect skins of gorillas, preserved with a preparation to be supplied by Dr. Gray, he would then claim the £2,000 in payment of his expenses; while, on the other hand, in case of failure, he would forfeit his £1,000.*

Habits of the Gorilla.—So much has been asserted of a marvellous character concerning these extraordinary animals, that we are glad to receive reliable information of a less romantic kind. Mr. Reade represents him as dwelling only in the densest parts of the forest, and feeding

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* This proposed wager, on the part of M. du Chaillu, is treated as a joke by the *Athenæum* (December 6); a contributor to which journal says that an African trader would supply the five or six specimens in two years for £100. We have no desire to defend M. du Chaillu's *illuminations*, but we certainly think it would have been more satisfactory if Mr. Reade had given us the *grounds* on which he stated that M. du Chaillu had never shot gorillas, &c. To us, it seems very much as though Mr. Reade had felt bound to write *something*, and had *done* it.—Ed.

exclusively on vegetable matter, so that one kind of grass is always a sure indication of his proximity. At noon and eve he approaches the village plantations in search of plantains, occasionally uttering a wild cry, but which in rage becomes a sharp bark. By day he moves along the ground on all-fours, sometimes ascending trees; and by night he selects a large tree as his sleeping-place. He is exceedingly wary and keen of scent. The female, when about to produce young, builds a nest of rude layers of dry sticks and small branches torn off from the trees by the hand. When wounded, or missed, as a rule they will charge on all-fours; but the natives, being as nimble as apes, often escape. In the case of a man who had his hand crippled by the bite of a gorilla, the animal seized the wrist with his hind foot, and dragged the hand into his mouth as he would have done a bunch of plantains. Only traditional accounts exist of the gorilla having killed a man; and it is less feared than the leopard.

The Gorilla in Liverpool.—So celebrated has this ape become, that the acquisition of a good specimen is an important event to a museum. The Free Public Museum of Liverpool has just acquired a specimen, superior, perhaps, to any in this country in size and excellence of preservation. An account of the arrival of this skin (which was presented to the museum by Mr. Duckworth) will be found in vol. i. p. 537. The same museum is particularly rich in illustrations of this animal, and possesses the largest gorilla-skeleton in Europe.

It has been very currently reported that a young living gorilla has been exhibited at Liverpool. This, however, is an error; the animal in question being only a chimpanzee. The only living gorilla which was ever imported into this country was in the possession of Mrs. Wombwell in 1855–56, and was examined by Mr. Moore, the curator of the Liverpool Museum. It was very docile and active, and is now in the possession of Mr. Waterton, forming one of the remarkable features of that gentleman's museum at Walton Hall, where it has been seen and examined by the writer.

The Unicorn.—The controversy concerning the existence of this animal still continues. The distinguished naturalist, Rüppell, received accounts many years back which inclined him to believe that some such animal existed in the deserts lying south of Kordofan. The zoological objection to the possibility of the existence of an animal with a single (true) horn on the middle of the forehead, is, that no such horn can grow upon a suture of the skull. It is believed, however, by some authorities that the male giraffe possesses a third horn, growing from the very centre of the frontal suture.

The New British Snake.—The newly-discovered Coronella has again been taken in the New Forest, whence a female specimen was obtained and taken to Mr. F. Buckland. While in his possession it produced six young, two of which were drowned in the water placed in the cage; the remainder appeared to be well cared for by the parent snake. It is thus proved that this reptile is, like the adder, viviparous.

The King Crab (Limulus polyphemus) found at Dover.—This remarkable animal, the nearest living representative of the ancient trilobite, has lately been imported in some numbers into Liverpool, alive; and also into London. One was taken to the Jardin des Plantes at Paris, for pre-

sentation to one of the professors; but, for some reason, it was not presented, and, returning to England, it was thrown overboard in the Straits of Dover. Soon afterwards a person presented himself at the British Museum, and offered a living specimen for sale, asking for it £5, and averring that it had been taken at Dover. Could it be that it was the same individual that was thrown overboard in the Straits? At all events, it should be borne in mind that if found in future it is a naturalized, and not an indigenous, animal on our coast.

Discovery of Aquatic Hymenopterous Insects.—Mr. Lubbock, F.R.S., exhibited, at the Entomological Society, two species of aquatic hymenopterous insects, one of which swims with its wings. They were found in a basin of water obtained from a pond. While examining the Entomostraca swimming about in it, he was struck with astonishment at observing a small, veritable, *clear-winged* insect swimming with an easy, graceful, jerking movement, by means of its wings. Although some of the hymenoptera had been observed to descend temporarily into the water, this was the first which had been met with which was truly aquatic. He proposed to call it *Polynema natans*, and remarked that, in a palæontological point of view, it was worthy of notice that, had it been found fossil, there would have been nothing to indicate that it was not a terrestrial or aërial animal.

Cultivation of Oysters.—M. Coste has communicated to the Academy of Sciences an account of the progress of his oyster-beds on the west coast of France. That waves and currents carry the ova of oysters is a well-known fact, since the walls of newly-erected sluices are often covered with them; but in the island of Ré, where the inhabitants have for some years been engaged in cleansing the muddy sediment from their coast, the oysters are now permanently established. Seventy-two millions of oysters, from one to four years old, is the lowest average registered per annum by the local administration, representing a value of about two millions of francs (£80,000).

Iron-banks built by Animalcules.—M. de Watteville announces, in the *Journal de l'Instruction Publique*, that in the lakes of Sweden there are vast layers or banks of iron, exclusively built up by animalcules. This iron is called lake ore, and distinguished, according to its form, into gunpowder, pearl, money, or cake ore. In winter, the Swedish peasant, who has but little to do at that season, makes holes in the ice of a lake, and probes for an iron-bank; then, letting down a sieve, the loose ore is shovelled into it with a ladle, mixed, of course, with sand, which is got rid of by washing it in a cradle. One man may obtain a ton of iron ore per diem by this process.

Fleet of Portuguese Men-of-War (Physalia pelagica) off the Isle of Wight.—This beautiful Medusa, which, as its name indicates, is oceanic, has lately made its appearance in great numbers off the Isle of Wight after a storm. Many of them were alive, and lived two days in a basin of salt-water. They are very rarely taken on British shores.

The Royal College of Surgeons of England has recently purchased for its museum a collection of specimens of animals from Professor Hyrtl of Vienna. The chief object of interest was the skeleton and stuffed skin of

a little animal, the Chlamydophorus Truncatus. This creature is about the size of a rat, and possesses certain anatomical peculiarities, concerning which Professor Hyrtl published a monograph in 1855. On this account, and also for its extreme rarity, the sum of £40 was given for that object alone. There are but two specimens known of: one is in the Anatomical Museum of the London Zoological Gardens; the other is the one mentioned above. Neither are there likely to be any more seen; for the only place in which the Chlamydophorus has been found was in the town of Mendoza, in the high lands of Chili, and which was totally buried, with its 14,000 inhabitants, by an earthquake in the Andes, in 1861.